Report By:
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in association with
Connell Wagner Pty Ltd

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HOBART CITY COUNCIL

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TRAMWAY PROPOSAL

SULLIVANS COVE.

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1.0 INTRODUCTION

1.1 The Brief

The Hobart City Council engaged Johnston McGee Gandy in association with Connell Wagner, to undertake investigation, preliminary design and costing of a tramway proposal primarily as a tourism venture but also to contribute to the inner city public transport network.

The intent of the tramway proposal is to link the Western end of Sullivans Cove (Salamanca Place) with the Cove's eastern end and the main railway line leading north along the western shore of the Derwent River.

The output from the Study will confirm the technical viability of the proposal and will provide capital costs which can be used in the preparation of a Business Plan. The Council separately engaged a Consultant, Mr David Corser, to explore funding options for the project and the output from this Consultancy will also be used in the Business Plan.

1.2 Background

The feasibility of reintroducing trams to Hobart has been under consideration by the Hobart City Council and other local groups for a number of years.

In 1994 the Council commissioned a report by Spiller Gibbons Swan Pty Ltd in association with Melbourne Transport International Pty Ltd on the feasibility of providing a tramlink between Sullivans Cove and North Hobart via the city centre.

The 1994 report led to the recognition that a tramway would have improved likelihood of success if it concentrated on the Tourist market and therefore would ideally connect the popular tourist areas such as the Salamanca Place, Watermens Dock, Constitution Dock, Victoria Dock, and the Botanic Gardens. The report also indicated that the proposed tramway could make other locations further afield more accessible using the main railway line including Incat at Prince of Wales Bay.

2.0 ROUTE SELECTION

2.1 Parameters (Desirables/Limitations)

To establish route options, a number of key parameters must be considered. They are grouped into desirables, limitations and other considerations, and are listed below:

Desirables, Route

- Service as many of the tourist facilities as possible.
- Travel through historic precincts.
- Provide scenic views e.g. waterfront.
- Duration of ride to be worthwhile, e.g. 1hr.
- Sense of travelling somewhere (i.e. not around in circles).

Limitations, Route

- Not too many un-scheduled stops.
- Gradients not too steep.
- Distance within power supply limits.
- Avoid industrial areas.
- Avoid traffic conflicts.
- Avoid pedestrian conflicts.
- Avoid heavy vehicle routes.

Desirables, Re Terminus and Stops

- Visible terminus.
- Adequate parking.
- Close to regular public transport.
- Short walking distance to tourist facilities.
- Close to public toilets.
- Flat area.

Limitations, Re Terminus and Stops

- Avoid congested areas.
- Not in busy roadway areas.

Other Considerations

- Extra distance for marginal benefit.
- Travelling on busy roads.

2.2 Base Route Physical Features

The base route considered in this proposal is shown on Drawings SK100 and SK101, indicated by a solid line.

The key physical features of the Base Route are:

- **Terminus**
  The route commences adjacent to Salamanca Place on the east side of Morrison St. This location provides high visibility in an open flat grassed area with no impact on established trees. It is close to most of the Tourist facilities of Salamanca Place and a short walk to the Public Toilets (200m) east. There are a large number of parking spaces nearby however these become congested on weekends. This area is reasonably serviced by local bus routes without being too close to a busy thoroughfare .

- **Morrison Street**
  From the terminus the route travels north along the centre of Morrison St. Consideration has been given to traffic conflicts at the intersection of Morrison St and Castray Esplanade in choosing the tram crossing location. The road width and traffic lane arrangement in Morrison St adjacent to Parliament Square will need to be modified to incorporate a 3m wide median for the tram track. A possible cross-section is shown in Figure 2.

  The existing median strip opposite the end of Watermans Dock would be widened to 3m for the tram track by narrowing the west bound lane to 3.76m.

- **Brooke St & Franklin Wharf**
  Turning sharply off Morrison St the tracks follow the centre of Brooke St then turn north eastward along Franklin Wharf. These quiet dockside areas are used for commuter car parking and due to the low traffic volumes the tram tracks along the centre of the street would only need linemarked separation. Some minor alterations to car parking would be necessary to maintain traffic lanes clear of the tram tracks.

  As well as the attractive historic waterfront buildings, this sections of the route passes a number of passenger ferry departure points and is therefore well suited as an intermediate passenger stopping location.

- **Argyle Street**
  Due to the restrictions of the bascule (lift) bridge (clearance only 3.8m) the route swings north west along the centre of Argyle Street. The south eastern end of Argyle Street is broad and carries little traffic therefore line marked separation in this area would be adequate.

  The section between Morrison St and Davey St is busier and a 3m wide traffic island is required. Consequently alterations to the south east bound lane and adjacent car parking are required. Also the triangular traffic island and left turn slip lane must be altered to separate trams from left turning vehicles as much as possible.

  As a minimum, delineation is required to define the traffic conflict points where traffic turning right from Argyle Street into Morrison Street crosses the tracks and where the track crosses the left turn slip lane from Davey St into Argyle St. These two locations present a high risk from tram/motor vehicle collisions, therefore signalisation of motor traffic and tram movements, may be necessary.

- **Davey Street - Constitution Dock and Victoria Dock Sections**
Because of the one way traffic arrangement and high traffic volumes in Davey Street the route must utilise the area between the docks and Davey Street. To allow the use of overhead power either initially or as a later addition, tracks should be located as far as possible, from the dock edge. Yacht mast and other dockside activities (pile driving, cranes, etc) are an ever-present danger with overhead wiring. It is also advisable to keep the heavier vehicle loads such as trams clear of the dock walls. The Marine Board of Hobart have advised of a previously imposed restriction that bans the use of vibrating rollers within four (4) metres of the dock edge.

  Additional considerations are that of tram safety near the dock edge and the Sydney - Hobart honour brick paving which has been placed in the footpath.

  The landscaping adjacent to Constitution Dock would require modifications particularly the relocation of 4 to 6 young trees. This section also contains a water main which may have to be modified.

  Where the route crosses the entrance and exit to the parking area between Constitution and Victoria Dock, delineation and redefinition of the traffic conflict points is required. Some parking alterations may also be required. This point is well suited as an intermediate passenger stopping location because of its central location to the docks and proximity to popular eating establishments.

  Approximately 12 parking spaces adjacent to Victoria Dock and parallel with Davey Street will be removed to provide for the tram route. The possibility of relocating these parking spaces to the dock edge could be considered however some form of barrier to prevent parking too close to the dock edge should be included. Use of the tram tracks to access these relocated parking spaces may cause delays to trams.

  Delineation and definition of traffic conflict points is required where the route crosses the north west end of Hunter St.

- **Davey Street - Hunter Street to Brooker Avenue**
From Hunter Street to Brooker Avenue (Institution of Engineers Building) the route utilises the eastern verge of the road reserve. The indented parking bay between Hunter St and Evans St may have to be rearranged or removed to provide space for the tracks clear of the footpath.

  The pathway and a number of small trees (approx 6) will have to be relocated to allow space for the tram tracks east of Evans St.

  This section of the route involves climbing a reasonable gradient (1 in 45 approx) and, being the steepest for the route, determines many of the tram power parameters.

  Near the Brooker Avenue intersection the route swings sharply to the east to follow the existing main line railway alignment.This would be an appropriate place for an intermediate passenger stopping location which could serve those wishing to visit the Cenotaph and also the nearby tourist facilities.

- **Main Line Railway Alignment**
  The tram route will utilise the existing main line railway tracks which pass near to the rail workshops then swing northwards around the east side of the Cenotaph and follow the west bank of the Derwent River.

  This main railway line passes under the Tasman Bridge approach ramps. The lowest clearance bridges is approximately 5.5m which is just acceptable for a double deck tram.

  After passing under the Tasman Bridge the route swings west ward to a point adjacent to the lower or rear entrance to the Botanic Gardens. This location will form a principal passenger stopping point and is well suited to being the northern terminus of the initial route. Depending on average speed of trams the travel time to this point would be a little under half an hour and therefore give a round trip of approximately 1hr.

  The option of continuing to a more distant destination is available however the increased running time would place heavy demands on resources. Faster vehicles which are more power hungry, would be required. More vehicles and consequently more staff would be required to run the same frequency of services. Larger fuel/battery capacity would be required to complete the journey. Tourists are less likely to want to spend long periods on board particularly when the northern sections of the route towards Prince of Whales Bay deviate inland and do not offer very attractive scenery.

2.3 Base Route Operational Features

The key operational features of the base route are as follows:-

- The grade of the route is generally flat
- The maximum grade is approximately 1 in 40
- The minimum radius curve is 20m.
- The length of the base route is approximately 3.4 km.
- The proposed maximum line speed is 20 km/hr
- There will be three intermediate passenger stopping points
  - Harbour Ferry Terminal
  - Davey St between Constitution and Victoria Docks
  - Davey St opposite Brooker Avenue
- The end to end travel time will be approximately 20 mins

2.4 Terminus Options

A number of variations to the base terminus were considered. See Drawing SK100. They are listed below with comments as to their relative value.

Alternative T1 - Tasman Moment Car Park

- Loss of carparking approximately 10 spaces
- Slightly further from toilets
- Slightly further from Salamanca Place Tourist area
- Requires no removal of trees
- Requires removal of mound in traffic island
- Reduces traffic conflict

Alternative T2 - Parking Lot Between Castray Esplanade and Salamenca Place Opposite No. 1 Shed

- Loss of parking approximately 8 spaces at Terminus
- No removal of trees
- Closer to toilets
- Requires median along centre of Castray Esplanade
- Loss of parking along Castray Esplanade approx 12 spaces
- Additional track and route length
- Not as visible.

Alternative T3 - Adjacent to Grain Silos

- No parking loss at Terminus
- Requires pruning of trees
- Traffic areas need to be defined and a pedestrian island is required
- Additional track and route length
- Requires medians along centre of Castray Esplanade
- Loss of parking along Castray Esplanade approx 20-25 spaces
- Poor visibility
- Close to toilets
- Provides closer access to southern Tourist business in Castray Esplanade.

Alternative T4 - CSIRO Area

- Terminus on CSIRO land may not be acceptable
- Substantially longer track and route length
- Requires substantial length of median along centre of Castray Esplanade
- Loss of parking along Castray Esplanade approx 40 spaces
- Requires additional stopping point near north end of Castray Esplanade
- Services southern tourist business in Castray Esplanade
- No existing public toilets.

2.5 Route Alternatives

A number of alternatives to the base route were considered. See Drawing SK100. They are listed below with comments as to their relative value:

- *Alternative A1 - Marine Board Land/Parking North Side of Castray Esplanade and east side of Morrison Street*

  This alternative route would run adjacent to No. 1 Shed (Princes Wharf) utilising the parking access lane. With some minor parking alterations and separation treatment from Castray Esplanade the trams would be allowed to travel from the CSIRO facility around to Watermans Dock with minimal traffic conflict or parking losses (6-8 spaces). This section of the alternative route would also avoid the cost of road alterations in Morrison St between Murray St and Castray Esplanade. However, it is understood that this option is not likely to be acceptable because of development proposals for the Princes Wharf sheds.

  There is also potential for tram delays and conflicts relating to parking manoeuvres by motor vehicles. Parking congestion on weekends could create severe difficulty for tram access unless delineation and enforcement of correct parking practice is applied.

Between Watermans Dock and Morrison St
This section of the route would follow parallel to the east kerb of Morrison St on what is presently a paved pedestrian area.

Detailed investigation of the south west corner of Watermans Dock would be required to assess if the dock walls can carry the tram load. Also the existing width between the dock wall and the adjacent Morrison St kerb is narrow and some kerb realignment or dock wall realignment may be necessary.

The existing indented parking bay at the west end of Watermans Dock would have to be removed to allow the route to avoid trees and the information display.

The alternative route would turn right into Brooke St and then continue as per the base route.

Although there may be some kerb alignment alterations, for this section of the alternative route, these would similar in cost to those for the base route. The main benefit associated with this section of the alternative route is the significant reduction in the traffic conflicts and delays to trams by avoiding the Murray St/Morrison St intersection and Morrison St/Brooke St intersections.

- *Alternative A2 - Argyle St North Eastern Side*
  This alternative route would run through the car parking spaces on the north east side of Argyle St. Although this alternative required removal of approximately 20 to 25 carparking spaces and involves trams running close to the adjacent building (Docksite Office occupied by Hobart City council), there is significant advantage in avoiding the traffic conflicts at Argyle St/Davey St and Argyle St/Morrisons St intersections. It would also avoid the cost of road alterations in this area required for the base route.

- *Alternative B - Franklin Wharf/Argyle St to Hunter St and via Rail Freight Terminal*
  This alternative route would cross the entrances to Constitution and Victoria Dock. The existing Bascule Bridge has clearance height of only 3.8m which is barely enough for a single deck tram vehicle. (Note : Limiting the tramway to single deck vehicles would threaten the viability of the project. Hobart needs to capitalise on its unique double deck trams). Whilst technically feasible the practicality of providing overhead power on the moving bridges creates a complexity and cost penalty which is not likely to be justified. Note the existing dock rail line is not suitable for trams due to the alignment which would cause trams to be running on the wrong side of the road head on into road traffic. There is also a section of track missing on the swing bridge.

  Because of the limited headroom of the bascule (lift) Bridge (3.8m), it would be necessary to construct a new bridge (opening type) parallel to the existing bascule bridge. The cost of new bridge ($2m) and technical difficulties prevents this alternative from being worthy of any further consideration.

- *Alternative C - Via Hunter St and Rail Freight Terminal*
  This alternative route turns south east into Hunter St from the base route adjacent to Davey St. The route would follow Hunter St then turn to pass through the car park area just east of the Centre for the Arts, resulting in the loss of approximately 10 spaces. Crossing Evans St the route would continue to follow the old dock railway alignment and join the existing main railway line.

  One advantage of this alternative is that it avoids the steep gradient of Davey St and this would reduce the demand on the tram power system.

  Apart from minor parking losses in Hunter St and the Centre for the Arts car park the most significant disadvantage of this alternative is that it passes through a particularly unattractive industrial and railway freight zone. It is also extremely unlikely that the rail freight terminal operators would allow the trams to pass through their container handling area. As the control of rail freight operations may be privatised soon, the status of the freight terminal is uncertain. Provision of overhead power for the tram would not be safe due to the use of large forklifts in this area.

- *Alternative D - Rail Freight Terminal (Australian National Rail Corporation - Tasrail)*
  This alternative route turns north east from the base route (adjacent to Davey St) just north of Evans St. This route crosses the Tasrail freight yard and follows one of the freight sidings to join the main railway line.

  An advantage of this alternative is that it avoids part of the steep gradient of Davey Street.

  It is extremely unlikely that Tasrail would allow trams to travel through their freight handling area. This area is also subject to an uncertain future depending on what the new Tasrail owners decide for the site. Large forkift activity in this area would also prevent use of overhead power for trams.

2.6 Extension Options

There are many options open for extension of the route. These may be limited by physical constraints such as steep gradients and restricted road space, apart from the expense of constructing tracks. Minimal cost extension options are based on use of existing railway track. Depending on type of vehicle power and vehicle availability trams could possibly run to Prince of Whales Bay, Royal Showgrounds, Berriedale and more distant destinations. These destinations may be considered as options for future expansion but should be subject to evaluation of tourist potential and financial analysis.

3.0 TRACK CONSTRUCTION AND PASSENGER FACILITIES

3.1 Track Construction Options

3.1.1 Requirements

The track performs a number of primary functions:
- Supports weight of vehicle
- Guides path of vehicle
- Distributes the vehicle load.

It also performs the supplementary functions depending on the location:
- Pavement for road vehicles
- Pavement for pedestrians.

The design of the track must consider other parameters depending on the environment in which the route runs:
- Minimisation of noise
- Surface drainage
- Visual aesthetics
- Minimise vibration/dynamic forces.

3.1.2 Sleepers/Ballasted Track

The combination of rails fixed to timber or concrete sleepers sitting in a bed of ballast (large screenings) performs the primary functions as well as reducing noise and vibrations.

This type of track construction can be adapted for vehicles and pedestrians by filling above the sleepers to the top of rail with full depth asphalt or with precast concrete slabs. It is rare to find this method used for anything other than short lengths, i.e. level crossings, pedestrian crossings and some freight yards. The installation and maintenance costs along with limited track life normally discourage its use.

This method presents particular difficulties for curved track less then 300m radius because of the special guard rail used.

3.1.3 Rail Cast in Concrete

Not only does this type of construction readily perform the primary functions it is well suited for use in locations where road vehicles and pedestrians share or cross the tracks. This is the typical method for many tramways.

Apart from a moderately higher installation cost its durability and minimal maintenance advantages have made it popular. It can be adapted to allow aesthetic surface finishes (eg brick paving, coloured asphalt, textured and coloured concrete) where required.

A common criticism is the higher noise level than compared with ballasted track. The replacement of worn rail is also more difficult and costly than Sleepers/Ballasted Track.

3.1.4 Rails in Elastic Seating in Concrete Slab

A ready means of overcoming the noise problems associated with concrete track constriction is to surround the rail in a special elastomeric encasement. Although very effective, this method adds substantially to the cost.

This method has been trialled over a number of years and despite a small number of noteworthy failures now appears to have overcome the earlier shortcomings and was recently utilised for parts of the Pyrmont Light Railway in Sydney.

One variation of this system is the casting of a concrete slab with open troughs. The rail is then suspended in these troughs while a rubber compound is poured into the trough, surrounding the rail.

The performance of this system of track construction is very similar to that of rail wrapped in rubber cast in concrete. However, not all types of aesthetic surface finishes are compatible with the pour-in method.

3.1.5 Rail Fixed to Concrete Slab

This method is normally utilised where the concrete slab is required to perform some other function for example bridge deck, tunnel floor, drainage barrier. The rails are commonly fixed to the slab using a propriety faster system which often incorporates some sort of resilient (rubber pad etc) feature to reduce noise and dynamic forces.

As this type of track construction is not primarily designed for pedestrian or vehicle use it is usually only used in tram systems where tracks are incorporated into a bridge deck and the bridge design does not allow capacity for the rail cast in concrete track construction.

In this circumstance a topping of bitumen or concrete is placed up to the top of rail when motor traffic or pedestrians share the tracks.

This construction method has a comparatively higher construction cost than other methods without offering any significant benefits apart from the bridge deck or tunnel application.

3.2 Typical Construction Cost Estimates

3.2.1 Basis of Cost Estimates

The following tabulation of costs is derived from raw cost data gathered from recent tramway construction work in Melbourne and Sydney. Where possible, the cost have been derived from work performance by contractors as a result of a competitive tendering process. This provides a more realistic cost for the works.

These costs assume that this project will be exempted from sales tax (and any other similar taxes eg GST).

3.2.2 Unit Costs for Straight Track

Rail cast in Concrete - $650/m
Rail on sleeper in asphalt - $730/m

Rail in elastic seating in Concrete Slab - $900/m.

Allowances must be made for curves less than 300m radius and for any points and crossings (switches).

3.3 Passenger Facilities and Operating Requirements

3.3.1 Passenger Facilities

A passenger shelter should be provided at each passenger stopping location. The shelters at the terminus should be large enough to accommodate approximately 40-45 people (one tram load/one coach load).

Each stopping location/shelter will include Timetable/Fare information, some advertising space and seating.

Additionally inclusion of a public address system, clock and next tram announcement could be considered at the terminus and important stopping locations.

If the vehicles can accommodate wheel chairs then loading ramps/platforms should be provided. These are also useful for other mobility impaired people.

3.3.2 Staff Facilities

The following basic staff facilities are essential:

- Toilets adjacent to terminus and layover points
- Communications - radio/mobile phone both on board and at the administration centre
- Mess room and locker room usually located at the depot or administration centre.

3.3.3 Traffic Interface

Depending on the location a number of different techniques are available to control the interface with road traffics.

In busy locations traffic signals may be required or existing intersection signals employed to allow trams to cross traffic flows. Trams are usually detected to call up the appropriate signal phase.

Where only trams are crossing and traffic flows are lighter flashing warning lights can be employed similar to railway level crossings. Tram approach is detected and flashing lights activated to warn traffic.

Where trams and traffic are travelling in parallel various methods are employed to separate them particularly if the trams need to travel in the opposite direction to the traffic. These methods include:

- Line marking and reflectors
- Kerbing - semi-mountable or barrier
- Surface treatment - textures, colours.

3.4 Comparison and Ranking of Terminus and Route Options

The sections above describe the physical features of the various terminus and route options. This section provides analysis and costing of the alternatives described.

3.4.1 Comparison of Terminus Options

Comparison of the terminus options (T1, T2, T3 and T4) against the base option "T" are summarised below. Estimates including track, civil and overhead power allowances.

T1	-	marginally cheaper	(-$10,000)
T2	-	more expensive	(+70,000)
T3	-	more expensive	(+155,000)
T4	-	most expensive	(+360,000)

Analysis of tourist impact/benefit would assist in the justification of more expensive options. However, this is outside the current brief.

Based on the desire to commence the project at a minimal cost Terminus Options T2, T3 and T4 can be reconsidered in the future when options for expansion are being reviewed.

Terminus Option T1, should remain open for review when the detail design stage occurs, as there is little to differentiate it from the base Terminus.

3.4.2 Comparison and Ranking of Route Options

The various route options have been assessed and scored in respect to the following criteria:

- Capital Cost (Track & Associate Civil costs)
- Tourist Value
- Public Transport Value
- Acceptability to Property Owners Including Affect on Property Development Opportunities
- Traffic Conflicts

The results are displayed in Table 1 and indicate that the Base case and the two minor variations (A1 and A2) have received similar high scores.

Options B, C and D received low scores not only because of their higher capital cost but also because they run through the rail freight areas. Running through the freight areas presents a number of major disadvantages including safety risks, conflict with heavy forklift and truck movements, conflict with train movements and the unattractive nature of this industrial area.

3.4.3 *Recommendation*

It is recommended that the base route be adopted for this project. The minor variations (A1 and A2) should remain open for further consideration at the detail design stage due to their operational advantages. The detailed design should take account of the status of adjacent land use particularly Docksite Offices in Argyle St and No. 1 shed and the surrounding car parking.

Options B, C and D do not warrant further consideration unless significant changes occur in the rail freight area and the moving bridges are replaced.

4.0 VEHICLES AND ASSOCIATED INFRASTRUCTURE

4.1 Vehicle Options and Sources

Our investigations regarding suitable vehicles for operating this tourist tram proposal in Hobart are based on the technical advice provided to the Council in Appendix A of the 1994 Report. We concur with these recommendations and have made further enquiries to update and expand the cost and availability information.

The most important aspects for vehicle selection are:

- Reliability
- Maintainable
- Historically significant
- Attractive
- Tourist appeal.

Some basic vehicle parameters have been recommended in the 1994 Report:

- Gauge - A gauge of 3'6" was recommended to allow trams to run on the main railway line. This gauge is also historically significant as the original tram system was 3'6" gauge.

- Tram Type - Double Deck body on a two axle truck. Consistent with early Hobart vehicles. This arrangement would maximise on tourist appeal.

A review of possible sources of tram vehicles has been conducted and initial discussions held with representatives from various tramway operators, historical groups and tram equipment manufacturers.

In summary, the results of our research are:

- Hong Kong Tramways are not in a position to sell or lease any of their fleet at present.

- The sourcing of trams from Melbourne is not practical because standard gauge trams are not readily converted to narrow gauge and there is a Government embargo on selling any of the older trams.

- The Historic Tram Societies contacted have advised that they are not in a position to sell trams or trucks due to the small number of vehicles they posses.

  Although some Historic Tram Societies sometimes lease vehicles to similar organisations, we have been advised that there are no narrow gauge trams available.

- We have contacted a number of international tramway operators and Historic Tram Societies. Groups contacted include:

  - Tramway Historical Society, Christchurch New Zealand
  - Hong Kong Tramways Limited, Hong Kong

- Companhia Carris deFerro deLisboa, Lisbon Portugal
- The National Tramway Museum - Derbyshire England

We have also gathered information via our contacts in Australian Historic Tramway Societies. Unfortunately, none of the information received to date has revealed a source for suitable vehicles.

Although there is a possibility that trams may become available in future this project cannot rely on the timing or cost being favourable. Particularly as there is so much worldwide competition for surplus vehicles.

- Advice from a number of sources indicates that manufacture of the vehicle from scratch is the only reliable method of attaining trams for this project.

4.2 Manufacture of Trams

The proposed route from Salamanca place to the Botanical Gardens has a round trip time of less than one hour. If an hourly service is proposed then only one vehicle will be in service at any time, two vehicles for a half-hour service and so on. It is preferable that at least one additional vehicle be available as a backup ready for service and that a complete set of spares for all special tram equipment be on hand. The spares should at least include:

- one complete truck (frame axles, springs, etc)
- two traction motors
- complete set of brake gear
- complete set of electric equipment
- bow collector.

A number of groups has expressed interest in supplying the specialist components for the vehicles.

The use of simple standard industrial and automotive technology should be maximised provided that it is consistent with proven tram technology. However, some components are peculiar to the tram industry therefore the design selected should ensure that these special components are readily maintainable.

Based on these principals we therefore recommend the following strategy.

Table 1

Component	Recommended Type	Basis of Recommendation	Potential Source
Truck	Brill 21E	Proven design for this vehicle. Readily maintainable numerous in service in historic fleets	- Bendigo Trust have patterns and could arrange for castings and assembly of truck. - Christchurch Tramway Historical Society have experience in making trucks.
Traction Motors	Modern Traction Motor. AC or DC	Smaller and lighter than original, can fit between 3'6" gauge wheels, more efficient, readily available and proven in service	Adtranz (AEG/ABB). Any other modern tram traction motor.

Component	Recommended Type	Basis of Recommendation	Potential Source
Brakes/Brake Gear	Original Style Mechanism, Air operated.	Suits Brill 21E truck, proven in service, readily available	Bendigo & Christchurch can arrange for copies of in service equipment.
Compressor	Modern Tram Compressor	Modern tram compressor more reliable, more efficient, spares readily available	
Traction Electrics	Modern solid slate chopper or invertor and control equipment	More efficient, minimal maintenance, readily available, proven in service.	- Energy Controls Pty Ltd - Adtranz - Siemens
Auxiliary Electrics	Modern solid state invertor	More efficient, minimal maintenance, readily available, proven in service.	- Energy Controls Pty Ltd - Adtranz - Siemens
Body	Copy of original Hobart double deck design	Replica of original, authentic appearance, none available for refurbishment, design proven in service. Use of modern materials improves durability and allows for easier maintenance	- Christchurch THIS - Goninan - Local Tasmanian Fabricators
Bow Collector	Replica of original	Authentic appearance, proven in service	- Local Australian Boilermakers

4.3 Alternative Power Systems

There are several alternatives for supplying power to the tram vehicles, each with their own pros and cons. Matters are relatively simplified for a tourist based facility compared to a commuter based facility, since only 1 or 2 trams are initially expended to be operating. Various options for providing power to the trams drive unit, are discussed below, and a brief note provided on the tram electrical characteristics.

4.3.1 Nature of Vehicle Load

Certain assumptions have been made in order to discuss the energy requirements of the vehicle particularly in relation to the weights, nominal speeds, and acceleration. The original Hobart trams are believed to have been powered by two off 30 hp (23 kW) motors, with a weight of approximately 16 ton (16.32 tonnes) laden.

The following parameters have been assumed for the proposed tram at this stage.

- Weight (total) — 16 tonnes
- Nominal speed — 20 km/hr
- Acceleration — $0.33s^{-2}$
- Tractive effort (on level) — 9.0 kN/tonne

Using the above approximately 8 kW of power is required to maintain constant speed on grade, an average of 24 kW to accelerate on level, and an average of 36 kW to accelerate on grade. Considering the peak power demand during starting on grade will exceed 36 kW for around 6 seconds, 2 off 18 kW motors are envisaged as being sufficient.

In nearly all of the options discussed below, the power train contains an AC induction motor, inverter, DC bus, and means of obtaining DC, either through on board generation, or an external collector system. The size, auxiliary requirements, and control components of the power train will vary with each option. The preferred motor is an AC induction motor, due to its compact shape, robustness, brushless construction, and degree of control available through flux vector control. The use of 2 x 18 kW motors on separate axles allows the tram to "limp" home in the event of one failing. The remaining motor can be controlled via a Programmable Logic Controller (PLC) to limit the starting currents resulting in longer acceleration times, but the same coasting speeds as for 2 motors.

The ability to accurately control AC motors high torque applications, such as trams, is an established technology. This can also be used for regeneration into either the OHE system or an on board battery, when used with an IGBT inverter, and an IGBT (Insulated Gate Bipolar Transistor) rectifier.

4.3.2 Overhead Electrification System (OHE System)

The merits of an OHE system are manifold, and one of the primary attractions of this system must be the authenticity it will give the project.

An OHE system consists of a continuous length of hard drawn copper conductor, from which current is taken by means of a collector (preferably the bow type for historical reasons) to the tram. Current is supplied as Direct Current (DC) from traction substations of which one or two would be required along the route.

The contact wire is raised at a positive potential with respect to earth, at around 600 V. The return currents are via the rails, and leakage paths. A constant voltage difference is available to the tram between the contact wire and the tram rails.

The contact wire is usually supported by either cantilevered arms, span wires, attached to poles, or directly to buildings. Some objections are likely to this system based on perceived unsightliness.

The use of an OHE Systems and its components is further discussed in the next section.

4.3.3 Underground Systems

There are two other methods, both of which are no longer in common use around the world. These are conduit systems, which consist of a slotted conduit containing a positive DC voltage conductor.

One system supplies current to the tram via a plough which passes down through the slots in the conduit to a live conductor. The system is severely disadvantaged in its maintenance requirements, expense, and danger of contact with live parts by the public (those with sufficient intent). However, unsightly overhead construction is avoided.

Another system is the surface contact system, where a series of buried studs are raised as the tram passes, to touch a contact skate attached to the car. This system is also no longer used owing to its high maintenance requirements and low reliability.

4.3.4 Battery System

The battery powered vehicle option offers a viable alternative to the relatively costly methods of reticulating power from remote locations (i.e. substations) via cables, to the tram car.

Considering only the vehicle itself, battery vehicles are about 46% energy efficient.

Given the number of vehicles on the route, the cost of auxiliary equipment required to power a vehicle via an on board battery is likely to be cheaper than the previously mentioned delivery system. The principle difficulty with a battery powered vehicle is the integration of the battery itself into the vehicle body, and the rapid exchange of discharged batteries to allow the tram to carry on. However, a typical tram power train arrangement is suited to an on board battery system, whether AC or DC traction motors are used, and a regenerative braking scheme could easily be incorporated allowing the battery to be recharged while braking.

A battery system recharged from the mains has the advantage of no tail pipe emissions and effectively becomes a"hydro" powered vehicle, since ultimately its primary generation base is hydro.

With the recent adoption of Federal legislation by some states in the US requiring that 2% of all vehicles sold in 1998 , 5% sold in 2001, and 10% in 2010, have zero tail pipe emissions, there have been significant developments in battery technology, and power train technology. It should be noted that Georgia Power in the US provided 70 battery powered trams to transport athletes during the Atlanta Olympics. Battery operated vehicles have been successfully used for milk deliveries in the UK for many years.

Terminal recharge stations are likely to be required, necessitating a reasonably rapid battery turnaround system. It should also be noted, that even with modern high performance battery such as Nickel Hydride, life times at 5 years can only be expected, and replacement cells required - potentially a high cost maintenance item. However the use of PWM chargers (Pulse Width Modulated) chargers in conjunction with industrial sealed lead acid batteries will also achieve similar life times. Batteries add approximate 4 Tonne to the vehicle weight.

Preliminary calculations indicate that for the duty imposed by the route would result in 210 off 12 volt heavy duty industrial batteries connected in one string being between 40% and 50% discharged after 5 hours of operation. This does not take into account regenerative breaking, or opportunity charging at the terminus. Rated lifetimes are increased if the battery discharge does not exceed 80%, therefore there is a margin of safety in these figures. Recurring costs every 4 to 5 years of the cost of the batteries are incurred with this system.

4.3.5 Internal Combustion Engines

The used of an internal combustion engine in the power train is also an option. One reason for adopting this system may be as an interim method of powering the tram, until an overhead system is constructed.

Inherent difficulties arise in the use of an internal combustion engine (ICE) without a supplementary power system such as battery, since the ICE torque capacity is not suited to tram acceleration. Trams require high torque at low speeds and less torque for cruising speeds, while an ICE develops little torque at low rpms, accelerating through nearly 75% of its rpm band to develop maximum torque. This would result in a sound suspiciously similar to a bus for the tram, and an inefficient power train. The intermediate placement of an DC voltage generator on the ICE, and electric drive motors does not alleviate any of these problems, however does allow the ICE to be removed at later date, and an OHE system provided in lieu, without significant alterations to the tram.

Considering only the vehicle itself, ICE vehicles are about 22% energy efficient.

ICE fuel sources such as LPG are inherently less efficient than Gasoline, and while having a bigger engine requirement (by approximately 5%) result in cleaner emissions than diesel or petrol. On current fuel pricing LPG is also more cost effective. The diesel engine is more robust, however, also noisier.

4.3.6 *Hybrid Systems*

The hybrid system overcomes the inherent limitations of the storage battery, combined with a method of on board power generation. Approached as a system, hybrid power provides a self adapting propulsion system utilising the batteries as an energy reservoir for load levelling. The ICE is run at a fixed speed, optimally selected for efficiency, and supplemented as required by the battery reservoir. Both systems are significantly smaller than their stand alone counter parts. Since the ICE can be set to a particular speed, acoustic treatment and exhaust emissions can be optimised.

In a series hybrid an ICE powers a generator, which either charges the battery or supplies the traction motors (reducing battery demand), all of the drive train elements are connected in series. An alternative option, but more complex to control, is to arrange for a direct mechanical coupling to the drive train, paralleled with a battery coupling.

4.3.7 *Steam Engines*

Steam engines offer a viable alternative power train and are a the unique tourist attraction in their own right, however it is noted that the authenticity of the tram itself is the primary objective, not the novelty of the power train. However, one of the features of advanced steam engines is the lack of visible steam. Closed systems minimise losses.

Steam engines can have an efficiency of up to 20% for advanced piston engines.

There are many advantages of using a steam driven engines which include the ability to deliver high torque at low speeds, speed control without a clutch (not possible with ICE powertrains), low noise emissions, and independence from reticulated power sources and corresponding support infrastructure. The lower weight of the engine results in a reduced tractive effort, requiring less power to move the vehicle on the level therefore offsetting to an extent the inherent inefficiencies of steam (the weight of the steam power train is estimated at 1/2 a tonne). Additionally estimates obtained from a supplier in Hobart indicate that the system could be provided at a very competitive price.

Some of the disadvantages of using a steam power train are that the non standard componentary requires specialised maintenance personnel, potential difficulties in readily available spare parts, relative fragility compared to electric motor systems (typically forces of 15 times gravity are experienced for traction motors), and right angled gearing to the axle (an engine motor shaft paralleled to the axle shaft - direct coupled - has proven to be more reliable than flexible angled spline connections)

4.3.8 Equipment Layout

The layout of equipment associated with all of the previously described option will vary. The systems requiring the least amount of on board equipment are those reticulated systems such as the OHE system. The only requirement would be for an inverter, breaking circuit, and AC motors (DC choppers on the incoming supply are not required since the voltage regulation would be good for 1 or 2 vehicles on line). These options would not require the use of a trailing vehicle.

The other options such as hybrid vehicle, battery vehicle or ICE vehicle will have larger spatial requirements for equipment and may require an additional trailing vehicle. Such a trailing vehicle could be modelled on historic trailing vehicles to match the tram itself. An additional weight of around 8 - 10 tonnes would be added requiring that the power train be suitably adjusted. The trailing vehicle could be used to carry additional passengers with the generation equipment concealed in the body. One important consideration would be running the tram around the trailer at each terminus. Additional track would be required for the 'run-around'.

It is therefore preferable to accommodate all equipment on board. Our initial research indicates that this is feasible. It is important to note, however, that inverters and battery systems are established technologies in tram ways, and are typically available in shapes conducive to tram car arrangements (eg dimensions of a Siemens 16 kW inerter charger are 1600 x 625 x 320mm - suitable for under seating or under floor). Until the tramcar layouts are established on board spatial arrangements cannot be developed.

4.3.9 Combined Systems

Combined systems are possible, and it is possible to integrate an overhead system with all of the other systems. While an overhead system could be decorative, to provide authenticity in some areas, it could also be used to boost on board battery, or bypass an on board ICE to alleviate noise.

Other combined systems are covered under hybrid systems.

4.4 Typical Overhead Power Supplies

The use of an overhead electrification system requires consideration of the methods of suspension, insulation, contact wire, current collection, and substations, which are discussed below.

4.4.1 *Contact Wire (Trolley Wire)*

The contact wire in an OHE system is hard drawn high conductivity copper. Given that the traffic loads are relatively small, requiring only 1 (possibility 2) substations, a reasonably heavy gauge of wire would be provided over the route (9mm diameter). This is to reduce the voltage drop over the route, and to negate the use of supplementary feeders from the substation. The contact wire would be supported directly from poles or span wires.

4.4.2 *Insulation*

Of primary importance is the insulation of the OHE contact from earthed items, such as the support poles. Normally the contact wire requires two levels of insulation to an earthed component, with can be provided by primary and secondary insulators on the supporting span wire, or cantilever arm. However, modern methods allow the use of parafil rope in lieu of in line ceramic insulators (Globe, Reel or Brooklyn types). The failure of any one insulator should not result in a short to earth.

The return rail does not need to be insulated from earth, since most of the return current will return through the nails, with some (say 10%) returning to the substation through the earth mass. A small step potential is likely between the rail and the area around it, but this is unlikely to exceed 6 to 10 volts.

4.4.3 *Poles and Supports*

The pole support system provides an opportunity share the use of existing and new poles to minimise the member of additional structures. Decorative poles were very common in early tramways, consisting of elaborately formed structures (although in reality a simple wooden pole will do). There are 2 types of pole to consider:

- Span wire poles;
- Cantilever poles.

The spanwire system has the advantage of not obstructing the centre of the roadway, and providing a flexible system of support for the tram wire. The span wire system consists of hanging the trolley contact wire by means of knuckles from a steel wire (or parafil rope) spanning between two poles or other structures such as buildings. The span wire system easily facilities the extension of the system to a double track system.

Cantilever poles (placed adjacent to the track) have minimal visual impact, and consist of a cantilever arm attached to the pole (two if double track) supporting the trolley contact wire over the track. This method allows the use of lighter weight poles as there is less lateral force on the pole than for the spanwire systems.

Ornamental scroll work has historically been used to strengthen the cantilever arm, however this will add significantly to the cost and has not been allowed for in the estimates shown.

Where substantial buildings exist, it is possible to dispense with poles and attach span wires directly to facades. (care must be taken to avoid the transmissions of vibrations into the building).

In locations where small radius track curves occur, the trolley wire must be supported more frequently than for straight sections to ensure it approximately follows the track centre line. This is achieved by the use of additional poles and span wire, commonly known as "cobwebs" or "knitting".

4.4.4 Collectors

The Hobart trams were renown for their distinctive collectors, which where of the bow type. For historical reasons it is envisaged that this type of collector would be preferred.

The advantages of the bow collector include its ability to stay in contact with the trolley contact wire, minimised tendency to chatter, and low maintenance requirements.

An alternative to the bow collector is the trolley pole which contains a readily replaceable carbon block in the contact shoe. The trolley pole requires more accurate overhead alignment and tensioning and is subject to lost contact (de-poling) more so than the bow collector.

4.4.5 Substations

The OHE system requires at least one substation and this would be located as close to the load centre as is practicable. Should an allowance for only one tram be required, then the substation would be quite small, rated around the 50 kVA mark. The use of Class VI rectifier transformers and rectifiers will allow for starting surges. Of importance would be the voltage drop along the line, which may require that two feeder substations are provided.

Given the function of the tram way primarily as a tourist facility, a dual redundancy arrangement within the sub station would not be required. A LV or HV supply would be taken from the Local Supply Authority passed through a rectifier (and transformer if required) onto a DC bus. This would in turn supply the contact wire, in parallel with the other substation if required.

Consideration must be given to electrolysis and the use of blocking diodes on the negative bus, and the bonding of rails, poles, and inground services.

4.5 Power System Costs and Recommendations

While the detailed design stage of the various power systems will determine the extent and layout of equipment, and therefore the cost, it is possible to establish relative costs for the various options. This will allow for a preferred option to be identified and developed.

The following cost comparisons are based on an assumption that the bare vehicle (no power train) cost will be approximately $700,000. This cost is very sensitive to the availability of suitable components or surplus units. The basis for comparison also assumes that, for a high reliability service, two complete vehicles and a complete set of spares are available. (A lesser scope could be adopted for an initial stage of implementation but this is not relevant for the comparisons.) The spares are assumed to include a complete power train and other specialist components eg. truck frame, wheel sets, bow collector. It is assumed that the value of specialist components will be equivalent to half the bare vehicle cost.

4.5.1 *Over Head Electrification System (OHE)*

Using an OHE system, typical components costs are:

• Vehicle power train (assuming all new components)	$300,000
• Poles, supply and install	$1,000 each
• Contact wire and spanwire supply and install	$110,000/km
• Substations	$60,000
Based on a route length of 3.5km with a mixture of cantilever poles and spanwiresupports the total estimate including vehicles is	**$3,410,000**

4.5.2 *Underground System*

• Vehicle Power Train	$300,000
• Underground electric system (Assumes 3 time cost of overhead system)	$2,100,000
Total based on a route length of 3.5km	**$4,810,000**

4.5.3 *Battery System*

• Vehicle power train	$400,000
• Battery (4-5 yearly cost)	$30,000
Total	**$3,040,000**

4.5.4 *Hybrid Vehicle*

• Vehicle power train	$400,000
- Genset	$30,000
- Battery (4-5 yearly cost)	$25,000
Total	**$3,115,000**

4.5.5 *ICE Vehicle*

• Motor drive	$130,000
Total	**$2,140,000**

4.5.6 *Steam Engine Vehicle*

• Steam Power train	$150,000
Total	**$2,200,000**

4.5.7 *Comparison and Ranking of Vehicle Power System Options*

The vehicle power systems have been assessed and scored in respect to the following criteria:

- Capital Cost
- Maintenance Cost
- Operating Cost
- Existing skills capability
- Historical value
- Sponsorship opportunity
- Vehicle Performance

The results are displayed in Table 2 and indicate that Overhead Electrication, Battery and Hybrid power options have received similar high scores and therefore warrant serious consideration for this application.

4.5.8 *Recommendation*

The Overhead Electrification Options received the highest score. However, this has a significant cost penalty. The hybrid and battery powered vehicle options, which would not present unsightly OHE structures and wires received the next highest scores. While they have some disadvantages such as high capital costs compared to the other on board power systems, and recurring battery replacement costs, they still compare favourably against the OHE system.

Additionally electric motor based options offers increased reliability and an established technology platform against the ICE and steam options.

The comparison between vehicle power systems is very sensitive to availability of components. Any opportunity to obtain serviceable surplus trams complete with traction motors and control equipment suitable for a 600VDC overhead system, would change the scoring to significantly favour the overhead power option.

Furthermore, The Marine Board has advised that overhead wiring is not an option within the dock area. This factor will require consideration as to the most appropriate compromise between the preferred route and preferred power system options when making final decisions on implementation.

4.6 Ancillary Plant and Facilities

4.6.1 Depot Facilities and Equipment

Based on the technical advice included in Appendix A of the 1994 Report the following comments are offered.

- **Depot functions**
  - minor servicing
    - clean
    - lubricate
    - sand
    - replacement (brakeshoes, light globes etc)
    - touch up paint

  - major servicing
    - lift bodies off trucks
    - wheel set removal
    - crash repairs
    - motor/gearbox overhauls
    - body overhaul and respray.

- Allowance must be made for the following ancillary requirements:

  - Administration Operations
  - Administration Maintenance
  - Revenue Control
    * cash handling
    * tickets
  - Purchasing

- Staff Amenities for:
  - Operations Staff
  - Maintenance Staff
  - Administration Staff
  - Meals, lockers, ablutions

- Emergency/Breakdown/Maintenance Requirements

  - Tow vehicle
  - Rerating equipment
  - Electrical overhead repair/maintenance
  - Track repair maintenance

When locating facilities consideration must be given to the following criteria:

- Depot
  - shared site with similar engineering facility
  - near terminals
  - near major passenger loading point.

- Administration
    - at depot
    - shared with similar admin facility
    - near major loading point

- Staff Amenities
    - at depot and at Admin
    - combined site shared facilities
    - share with co-tenant

- Emergency/Breakdown/Maintenance
    - close to centre of route
    - at depot
    - at subcontractor/maintainers depot

4.6.2 Recommendations

There are two approaches to choosing depot/administration facility sites. Traditionally depots have been removed from public areas because of their industrial nature.

In the case of Tourist Tramways there is some advantage in locating the depot in a relatively high profile public location where any spare trams provide a visual attraction to draw attention to the tramway operation. The depot can also be used as a venue to display interesting tram equipment and historic relics in a relevant context. With a little attention to public safety issues, tours of the depot and viewing areas can be included (similar to the Bendigo tramways example).

We would recommend that on the basis of base route being adopted, a depot be located near the Salamanca Place Terminus. Preferably using a section of an existing building such as No. 1 Shed. This would meet the majority of the criteria for the depot and administration facility particularly if the remainder of the building can be developed for use by compatible tourist activities.

5.0 SURVEY OF MAJOR STAKE HOLDERS

5.1 General

A requirement of the project brief was that contact be made with major stakeholders ie. those companies, corporations etc, which might be affected in any way by the tram, whether physically, such as the tram crossing land owned or controlled by them, or commercially by impacting in any way on their business.

A short list of stakeholders was included in the brief, this list was expanded through discussions with Council Officers and the On Track Committee.

The form of contact varied from personal interviews to telephone conversations and the exchange of letters or facsimiles.

A standard form "Major Stakeholder Interview" was used as a basis for items to be discussed and allow easy summary of the information obtained. Copies of the completed form from each interview are included in Appendix A of this report.

The major stakeholders contracted were:

- Tasmanian Transport Museum Society - Mr Graham Clements
- Sullivans Cove Merchants Association - Mr Jeffrey Thomas
- Botanical Gardens - Mr David Bedford
- International Catamarans - Mr Robert Clifford
- Department of Transport - Mr Milan Prodanovic
- Marine Board of Hobart - Mr Dick Knoop
- City Heart Association - Mr Barry Pickard
- Australian National Tasrail - Mr Rene Blaszard

5.2 Project Support

Support was indicated for the project by all stakeholders including the Marine Board of Hobart over whose land part of the track must be laid and the Department of Transport who will have to be satisfied with the suitability and safety of the interface between the tram and normal road vehicle traffic.

Australian National - Tasrail, the other stakeholder over whose land and track the tram may run, were not prepared to commit as fully as the Marine Board, due to their imminent sale, preferring to leave such a commitment to the new owners. They did however raise some areas of concern which they felt the new owners may wish to consider and these are contained in their letter to JMG of 21 May 1997, a copy of which is included in Appendix A.

The two main areas flagged were, the possible cost of upgrading the rail track to bring it up to an appropriate standard for passenger traffic and potential safety/operational problems if the tram route transversed the Macquarie Point shunting yards.

5.3 Financial Support

Financial support for the project was not offered by any of the contacted stakeholders.

5.4 Support in Kind

Mutually beneficial joint promotion was considered possible by the Botanical Gardens and City Heart Association.

International Catamarans offered to consider joint use of any track under their control and also of a train station they propose for construction near the Royal Engineers Building.

The Tasmania Transport Museum Society indicated they are able to provide advice on tram construction, historical information and restoration and the Department of Transport will provide Traffic Management Advice.

In addition to indicating that they will allow tram tracks to be laid over the land, the Marine Board also indicated that they would consider joint use of infrastructure such as poles, the provision of land for a depot and also they would not require payment for use of roadways by the tram. The provision of land would be dependent on availability and suitability. At this time they have nothing specific to offer.

The route of the tram, the detailed positioning and details of construction of the track, will all require detailed discussion and acceptance by the Marine Board, however subject to this they have indicated support in principle to the tram route being along Morrison Street, up Argyle Street and across the top of Constitution and Victoria Docks, with the track being positioned down the centre of Morrison Street so as to be clear of parking and areas used for concessions etc during events such as the Sydney to Hobart yacht race.

5.5 Potential Problems

A number of problem areas were flagged by stakeholders but most fell into the category of being avoidable with appropriate selection of the route and detailing of the installation.

Of most significance were:

- the advice from Tasrail that expenditure would be required to upgrade their track for passenger use and

- the statement from The Marine Board that the use of overhead cables within the dock area (where there is frequent forklift and other heavy vehicle manoeuvring) is not an option due to safety concerns.

The safety of pedestrians crossing the Lower Domain Road at the Botanical Gardens was raised by both the Botanical Gardens and Tasmanian Transport Museum Society as requiring consideration.

5.6 Benefits

All stakeholders indicated that they considered the proposal would be of benefit to the community generally and particularly those businesses in close proximity to the route.

Particular comments were:

- Improved access to the Botanical Gardens
- Tie the waterfront right across Sullivans Cove and to the Botanical Gardens together and provide the potential for more people to see more and stay in Hobart longer with the consequential increases spending with local business.
- Possible commuter use if linked with future carparks
- Improve tourism facility for Hobart
- Enhancement of transport system. Linking with ferries, Metro etc.
- Improved access for older and less physically active persons to the total Sullivans Cove area and the Botanical Gardens

5.7 Control Points

Control points ie tram stops, considered desirable by stakeholders were as follows:

- Royal Engineers Building
- Proximity to cruise and naval ships visiting Hobart
- As close as possible to Franklin Square
- Salamanca Place
- Elizabeth Street Pier
- Between Constitution and Victoria Docks
- Hunter Street
- Beginning of the cycle track to the Northern suburbs
- Proximity to the Grand Chancellor Hotel, Wool Store and Gas Works
- Ferry Terminals and harbour cruise operations
- Multi-storey carparks if/when constructed

6.0 CONCLUSIONS AND OPTIONS

This project is capital intensive but it is possible to adopt a staged implementation to manage the cashflow. It is recommended that the "base route" be adopted using the overhead electrification concept and that an initial stage of development be pursued which provides a service between the proposed base terminal at Salamanca Place and Hunter Street. Furthermore, it is recommended that the service should commence with one vehicle and a minimal spare parts inventory. A simple light weight awning structure would be provided at the Terminus for weather protection until a depot is provided in later stages. This initial stage would exhibit a risk of lower service reliability because there is only one vehicle and less spares, but this situation could be managed to avoid major disruptions.

The estimate of the cost of this initial stage of development is:

Track 770m		$590,000
Overhead 770m		$220,000
Roadworks		$50,000
Service Diversion (Provisional Sum)		$80,000
Landscaping		$40,000
Awning roof for tram Storage		$30,000
One vehicle including minimal spares		$1,000,000
	Sub Total	**$2,010,000**
Permits, Fees, Legal Costs, Planning Permits, Project Management, Consultancy Fees	10%	$201,000
Contingency	20%	$402,000
	Initial Implementation Cost	**$2,613,000**

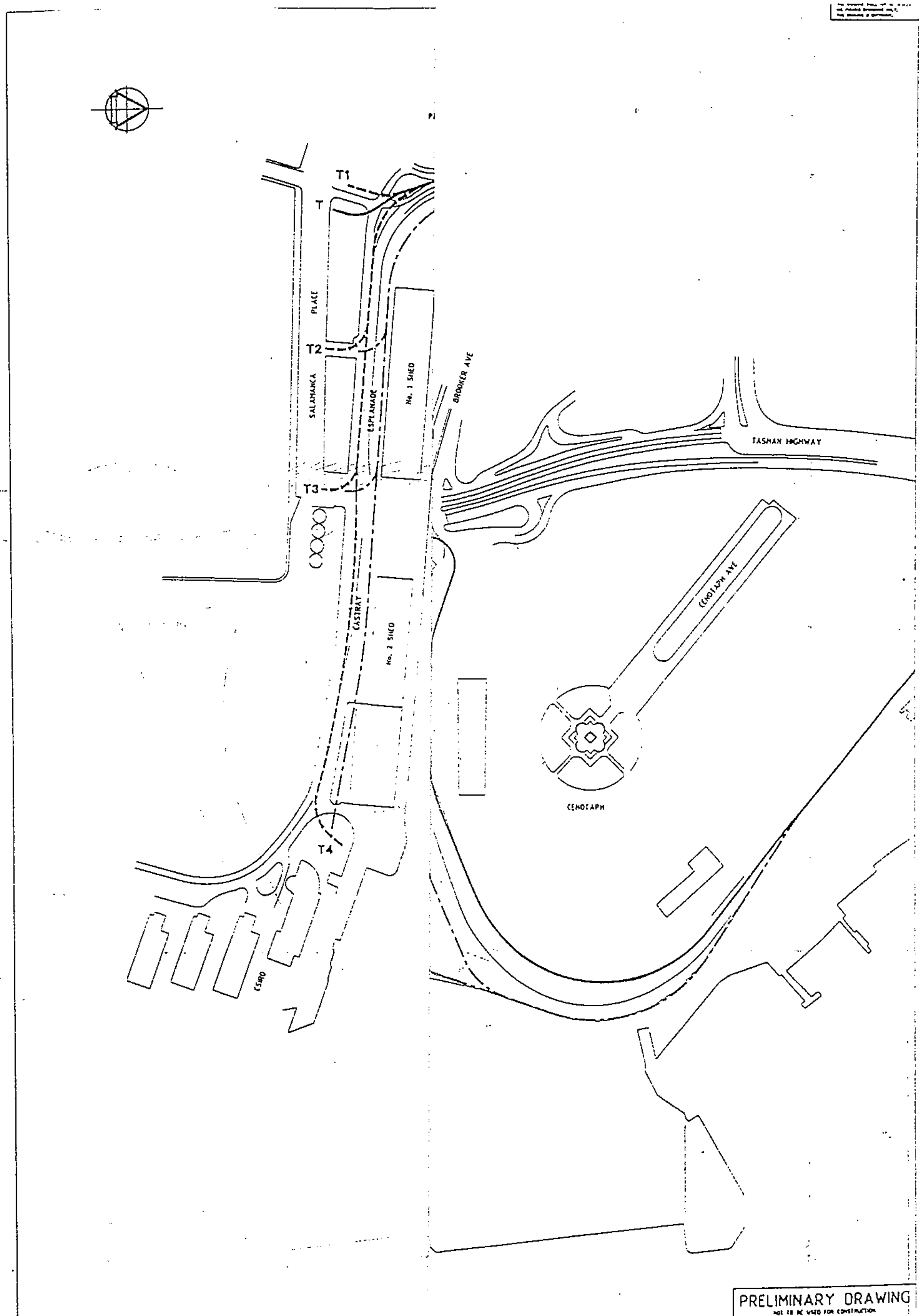
The recommended second stage of development would provide the 1.1km "base route" described in the Report together with two vehicles, adequate spare parts, depot shelters, etc. The estimate of the capital cost for Stage 2 is as follows.

Track 1.1km	$940,000
Overhead 3.5km	$760,000
Roadworks	$50,000
Service Diversions (Provisional Sum)	$100,000
Landscaping	$50,000
Depot, Admin, Shelters and Signage (based on 1994 report)	$400,000

Two Vehicles incl. first line spares		$2,650,000
	Sub Total	$4,959,000
Permits, Fees, Legal Costs, Planning Permits, Project Management, Consultancy Fees	10%	$495,000
Contingency	20%	$990,000
	Total Project Cost	**$6,435,000**
	Less Initial Implementation Cost	$2,613,000
	Additional Stage 2 Cost	**$3,822,000**

Other Matters:

- The infrastructure cost of the project (eg. Track, Overhead etc) are reasonably well defined. However, these should be reviewed at the detail design stage.
- The vehicle costs provided in this report assumed that the vehicles would be manufactured from scratch using existing heritage examples in other cities as the basis for fabricating special components.
- As vehicle costs are very sensitive to availability of suitable components, any opportunity to reduce vehicle costs should be actively persuaded.
- Acquisition of suitable surplus trams provides the best opportunity to reduce the vehicle cost. Existing trams can usually be adapted and restored at a significantly lower cost than constructing new vehicles.
- We therefore recommend that local and international organisations be monitored and a budget set aside to purchase suitable vehicles and components if they become available.
- Once acquired and restored an authentic looking tram is likely to create significant interest and enthusiasm for the project which may be capitalised on to gain funding for the infrastructure.



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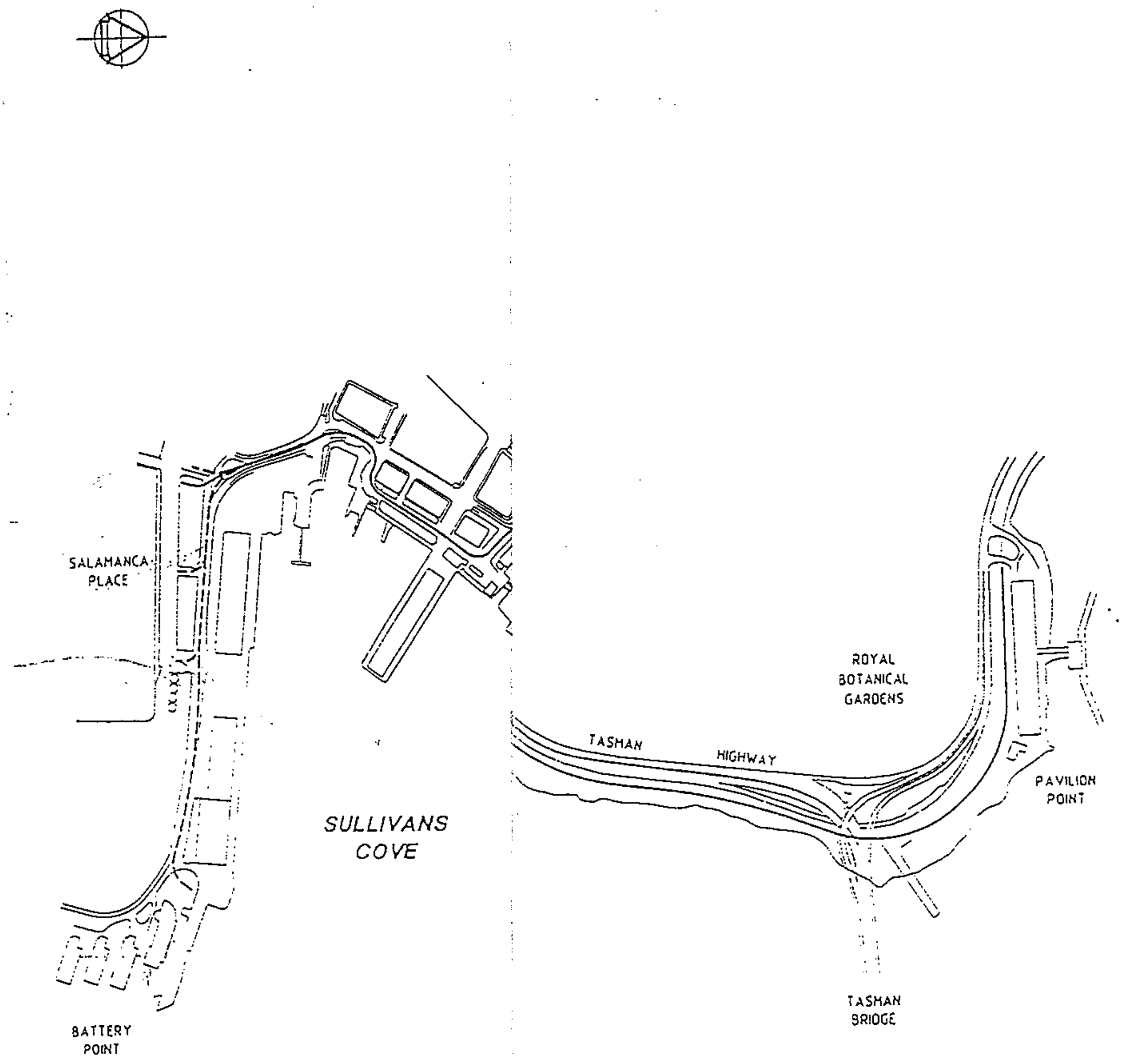


PRELIMINARY DRAWIN

HOBART TRAM PROPOSAL

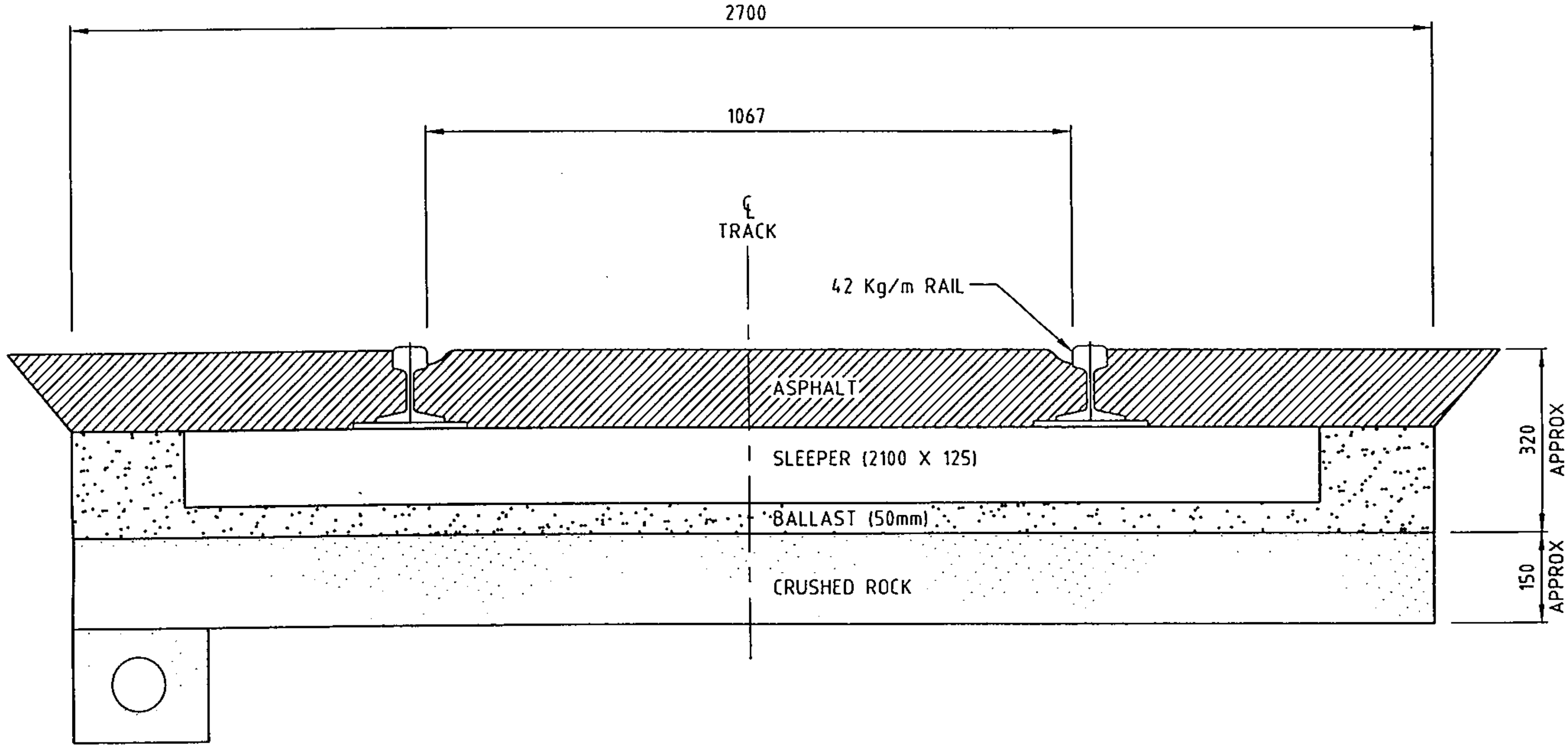
ARH

GO

PROPOSED TRAM ROUTE

N.T.S.

SK101



RAIL ON SLEEPER IN ASPHALT

NOTE: APPROXIMATE DIMENSIONS ONLY NOT TO BE USED FOR CONSTRUCTION PURPOSES.

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

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Project	TRAM PROPOSAL
Designed by	A.R.C.
Drawn by	D.P.K.
Checked by	-
Approved by	-
Title	RAIL ON SLEEPER IN ASPHALT
Scale	N.T.S.
Job No.	5217.01C
Date.	JUL 97
Drawing No.	SK1
Rev.	-

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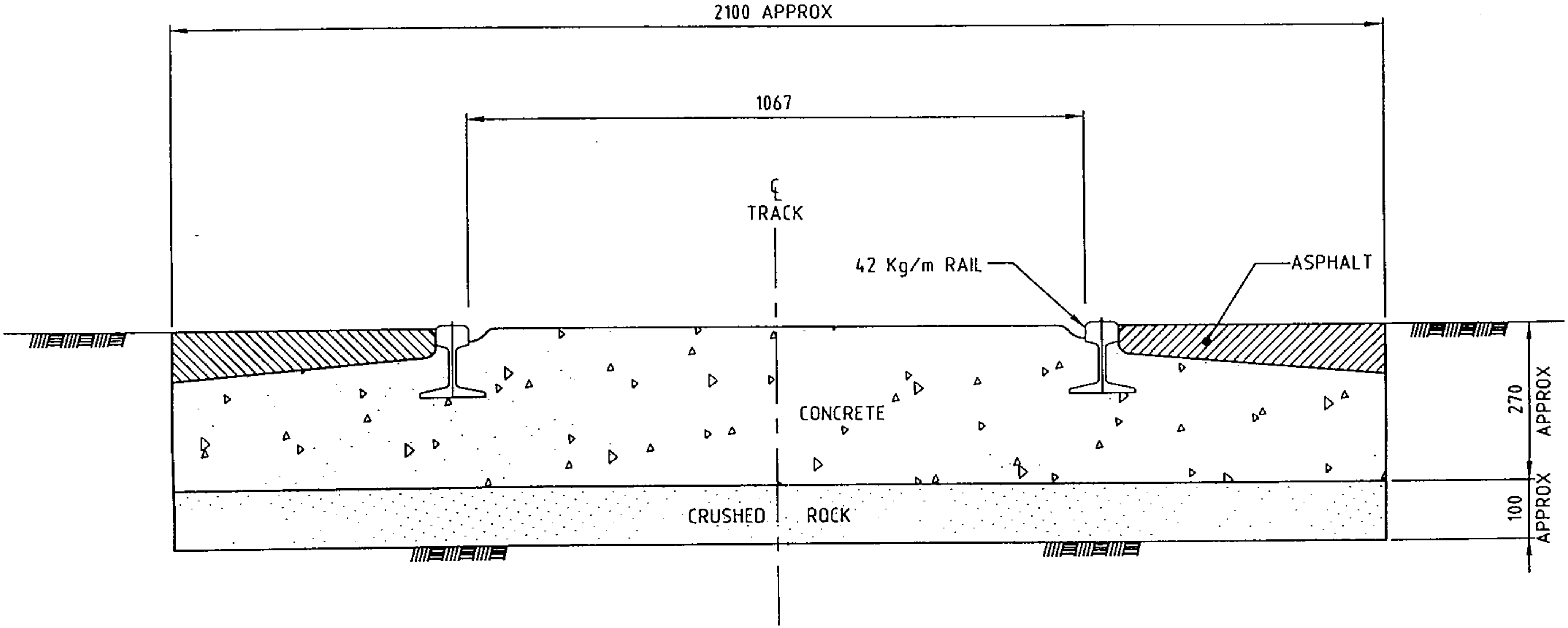

TYPICAL TRAM TRACK CONSTRUCTION
RAIL IN CONCRETE

NOTE: APPROXIMATE DIMENSIONS ONLY NOT TO BE USED FOR CONSTRUCTION PURPOSES.

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

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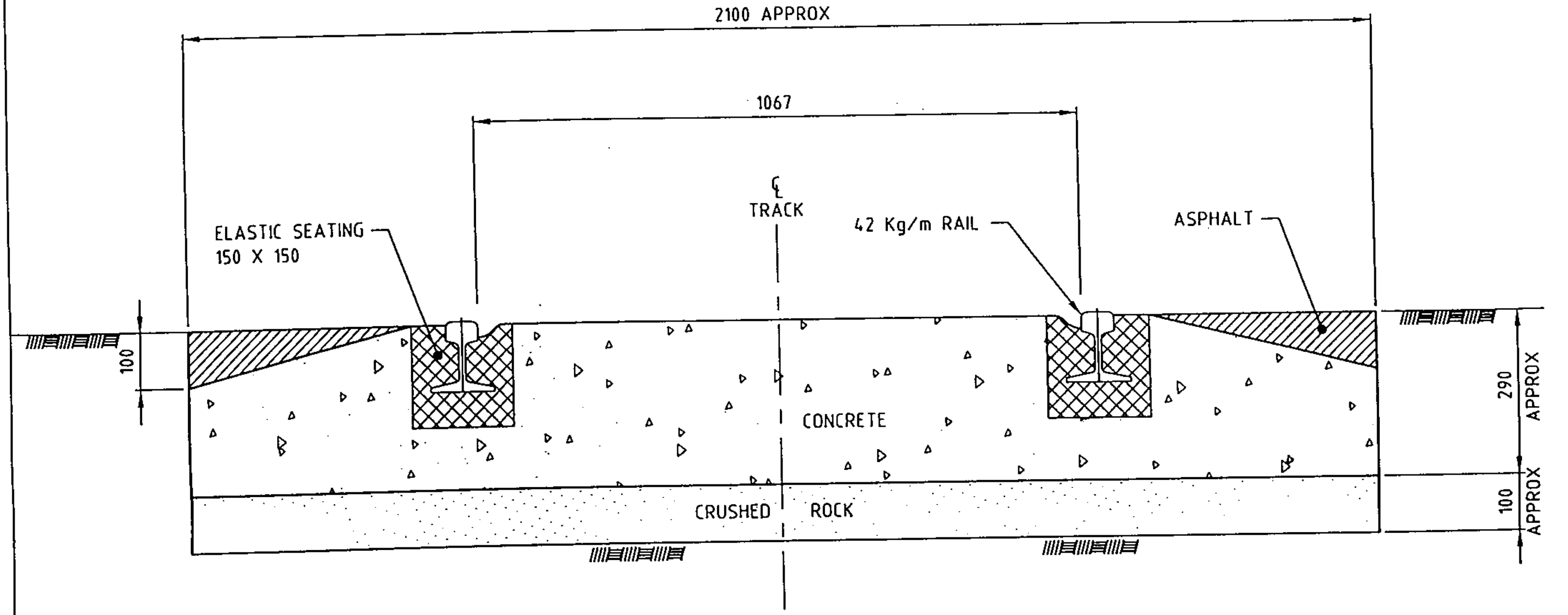
Project	HOBART TRAM PROPOSAL
Designed by	A.R.C.
Drawn by	D.P.K.
Checked by	-
Approved by	
Title	TYPICAL TRAM TRACK CONSTRUCTION RAIL IN CONCRETE
Scale	N.T.S.
Job No.	5217.01C
Date.	JUL 97
Drawing No.	SK2
Rev.	



RAIL IN ELASTIC SEATING IN CONCRETE

NOTE: APPROXIMATE DIMENSIONS ONLY NOT TO BE USED FOR CONSTRUCTION PURPOSES.

PRELIMINARY DRAWING
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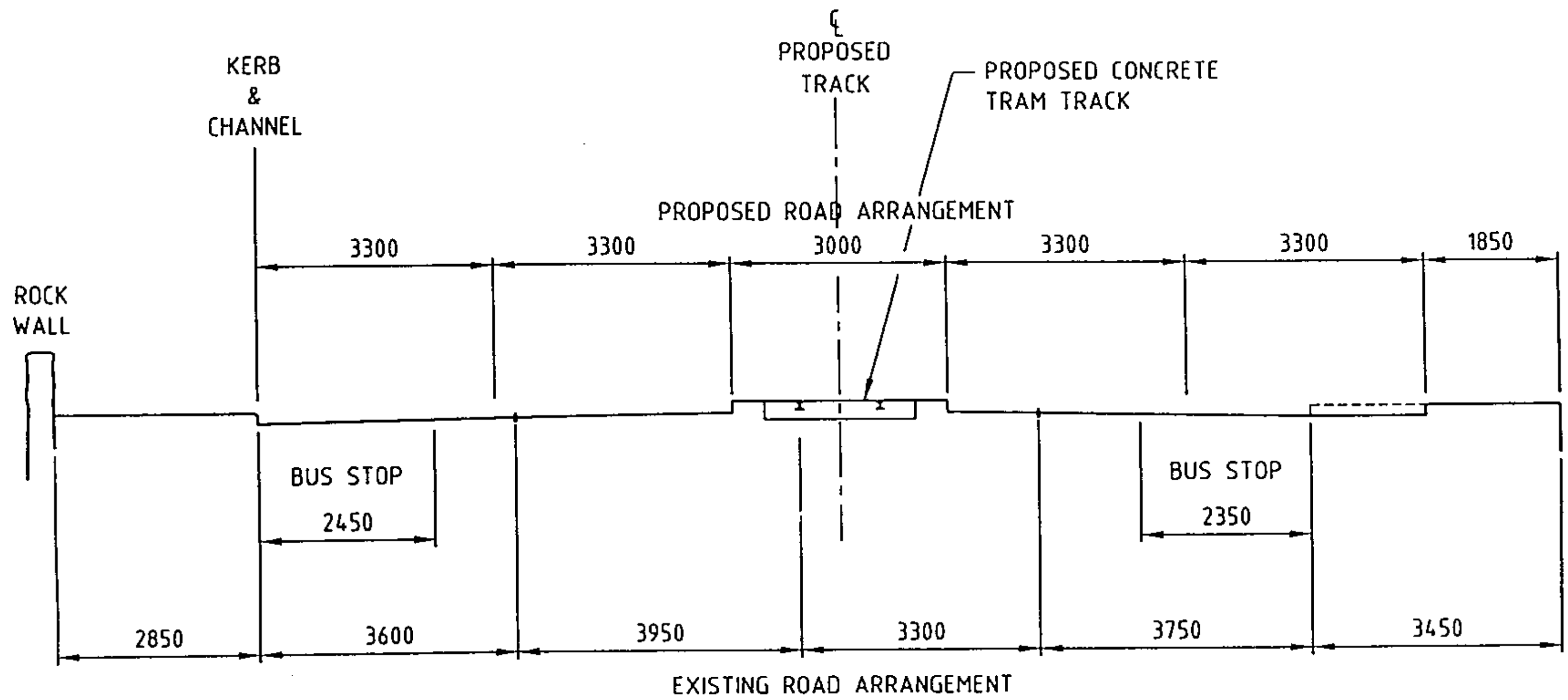
Project	HOBART TRAM PROPOSAL
Designed by	A.R.C.
Drawn by	D.P.K.
Checked by	-
Approved by	-
Title	RAIL IN ELASTIC SEATING IN CONCRETE
Scale	N.T.S.
Job No.	5217.01C
Date	JUL 97
Drawing No.	SK3
Rev.	-



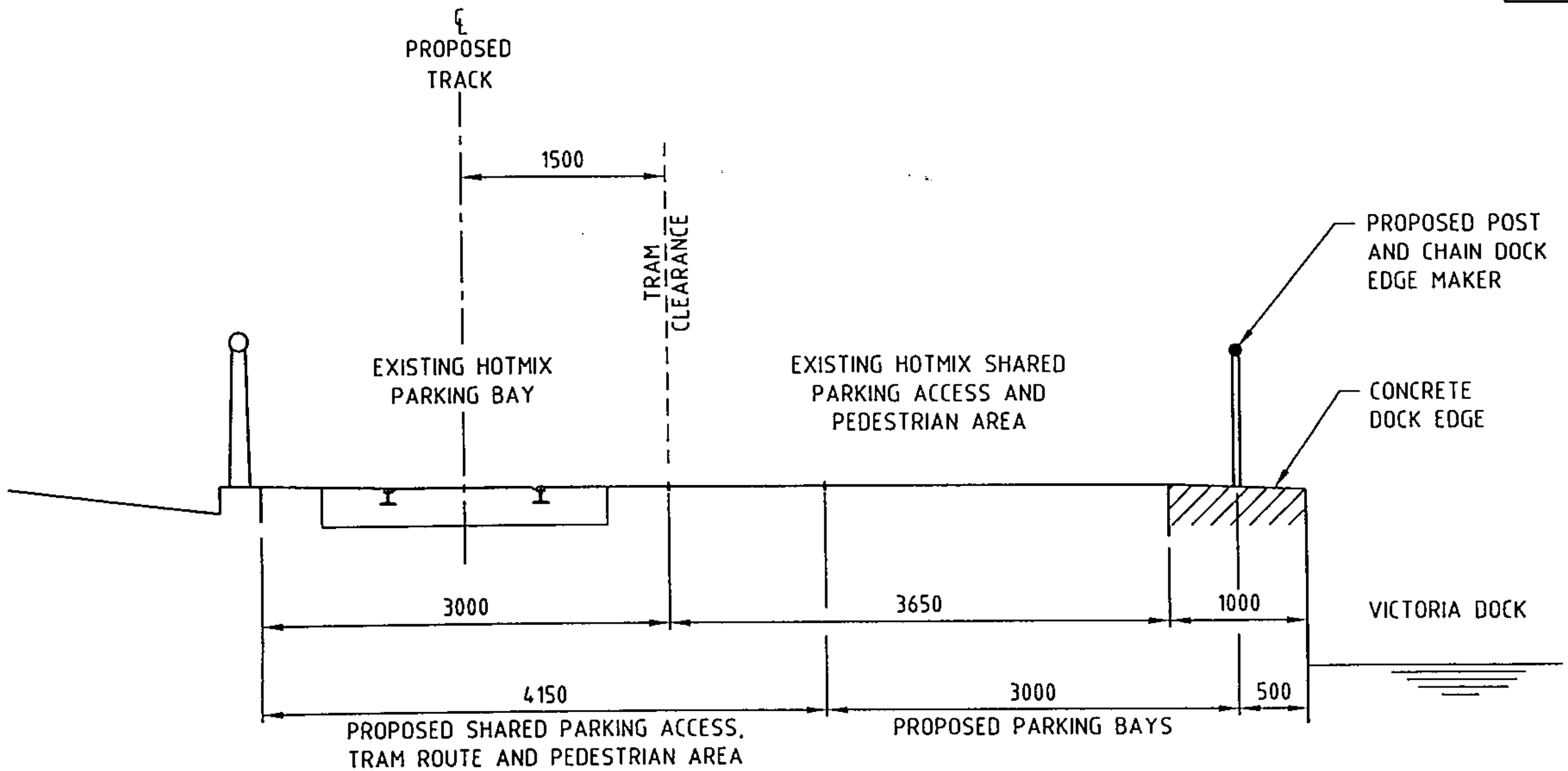
CROSS SECTION OF MORRISON STREET OPPOSITE PARLIAMENT SQUARE

NOTE: APPROXIMATE DIMENSIONS ONLY NOT TO BE USED FOR CONSTRUCTION PURPOSES.

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

Connell Wagner
Engineers & Managers
Connell Wagner Pty Ltd
A.C.N. 005 139 873
60 Albert Road,
South Melbourne 3205
Victoria, Australia

Project	HOBART TRAM PROPOSAL
Designed by	A.R.C.
Drawn by	D.P.K.
Checked by	-
Approved by	
Title	CROSS SECTION OF MORRISON STREET OPPOSITE PARLIAMENT SQUARE
Scale	N.T.S.
Job No.	5217.01C
Date	JUL 97
Drawing No.	SK4
Rev.	-



CROSS SECTION BETWEEN DAVEY STREET AND VICTORIA DOCK

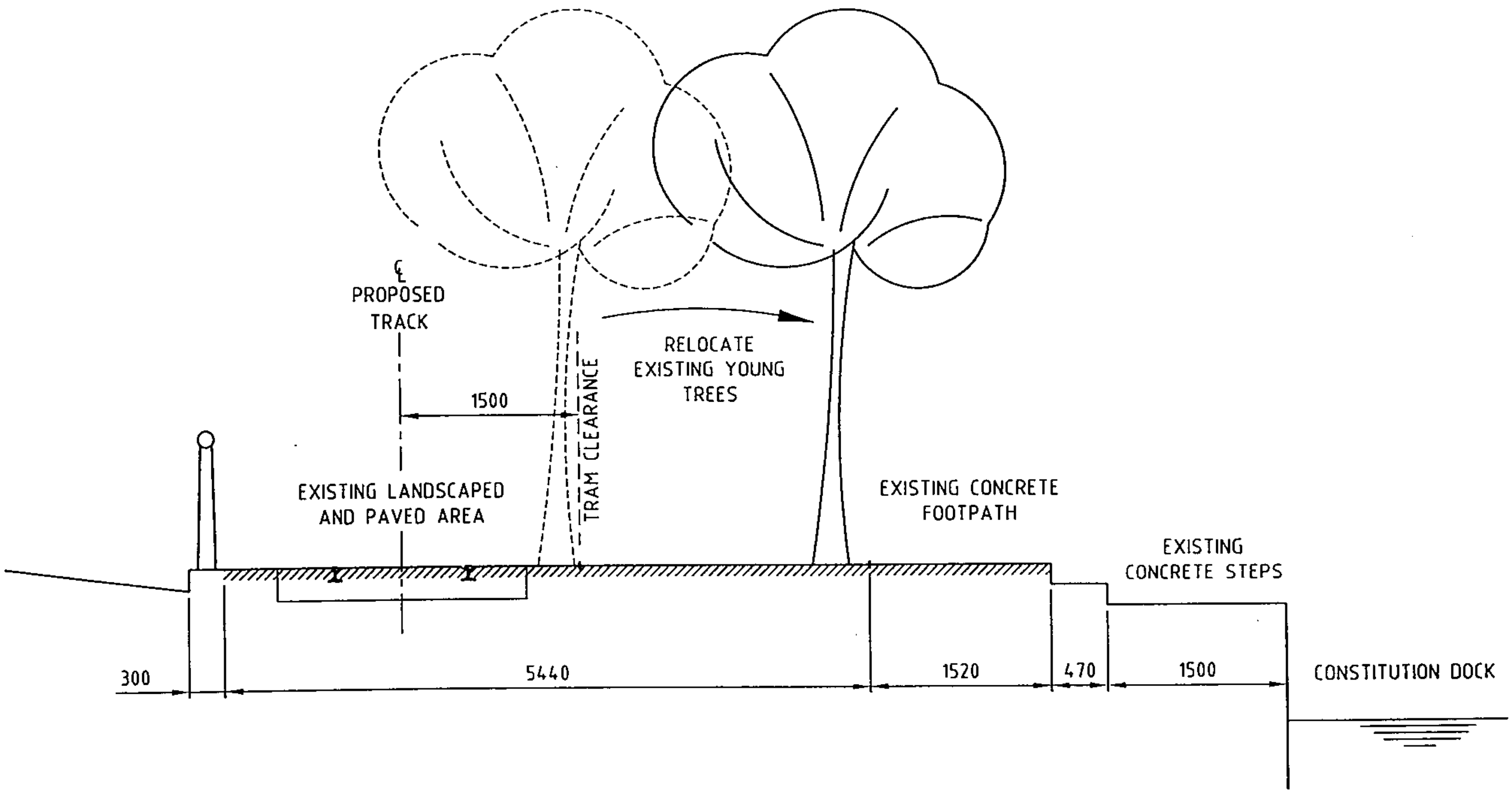
NOTE: APPROXIMATE DIMENSIONS ONLY NOT TO BE USED FOR CONSTRUCTION PURPOSES.

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

Connell Wagner Engineers • Managers	Connell Wagner Pty Ltd A.C.N. 005 139 873 60 Albert Road, South Melbourne 3205 Victoria, Australia	Project: HOBART TRAM PROPOSAL	Designed by: A.R.M. Drawn by: G.D. Checked by: - Approved by: -	Title: CROSS SECTION BETWEEN DAVEY STREET AND VICTORIA DOCK

Scale	N.T.S.
Job No.	5217.01C
Date.	JUL 97
Drawing No.	SK5
Rev.	-

Telephone 03.96970333, Facsimile 03.96970444



CROSS SECTION BETWEEN DAVEY STREET AND CONSTITUTION DOCK

NOTE: APPROXIMATE DIMENSIONS ONLY
NOT TO BE USED FOR CONSTRUCTION
PURPOSES.

PRELIMINARY DRAWING
NOT TO BE USED FOR CONSTRUCTION

Connell Wagner
Engineers • Managers

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South Melbourne 3205
Victoria, Australia
Telephone 03.96978333, Facsimile 03.96978444

Project: HOBART TRAM PROPOSAL

Designed by: A.R.M.
Drawn by: G.D.
Checked by: -
Approved by:

Title: CROSS SECTION BETWEEN DAVEY STREET AND CONSTITUTION DOCK

Scale: N.T.S.
Job No.: 5217.01C
Date: JUL 97
Drawing No.: SK6
Rev.:

APPENDIX A

MAJOR STAKE HOLDERS INTERVIEWS

HOBART CITY COUNCIL **TRAMWAY PROJECT** **SULLIVANS COVE, HOBART**	**Johnstone McGee & Gandy Pty Ltd** in association with **Connell Wagner Pty Ltd**

MAJOR STAKEHOLDERS INTERVIEW

Stakeholder:	Marine Board of Hobart
Stakeholder Representative:	Secretary Dick Knoop
Date of Interview:	14 May 1997

QUESTIONS

1. **Support the project in principle** — Yes

2. **Would consider financial support** — No

3. **Would consider support in kind** — Yes
   - **Access over land** — Yes
   - **Provision of land for tracks** — Yes centre of roadway generally. Some problems.
   - **Provision of land for sheds, depot etc.** — Yes but nothing specific to offer at moment
   - **Use of existing track** — Not useable

4. **Support Other:**
   - Sharing of poles
   - Not require payment for use of roadway.

5. **Problems**
   - Route across top of Victoria Dock - East of docks preferred.
   - Overhead restrictions because of use of fork lift trucks etc by MBH. Use of track or battery power preferred. Safety could be of concern and down time for tram.
   - Through carpark at Princess Wharf may not be possible with possible proposed development.
   - Route through Toll / Tasrail dependent of final owner of Tasrail property.

6. **Any events, activities, functions which might impact on route options / selections.**
   - Sydney Hobart - uses edges of docks / pavements so centre of roadways better - common use, vehicles, trams pedestrians as through way.
   - Other events ditto

7. **Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.**
   - No envisaged problems
   - Recheck when route known and extent of cutting of slabs etc defined.

8. **Benefits to your organisation**
   - Improvement to business of people in the area who lease from MBH etc.

9. **Benefits to the community & Business.**
   - Possible commuter / carpark transfer early am - free ?

10. **Desirable control points ie tram stop or transport interchange points.**
   - Multi-storey carpark if any when built

HOBART PORTS CORPORATION Pty Ltd
ACN 078 720 180
1 Franklin Wharf, Hobart, Tasmania, 7000
Phone: (03) 6235 1000 Fax: (03) 6231 0693
Email: sec@hpc.com.au

Correspondence to be addressed to: Company Secretary, GPO Box 202B, Hobart Tasmania, 7001

Ref: 05-745

29 August, 1997

Mr Ian Johnston
Johnstone McGee and Gandy Pty Ltd
117 Harrington Street
Hobart 7000

Dear Sir

HCC, SULLIVANS COVE, TRAM STUDY
In reply to your letter of 7 July 1997

Reservations about proposed route

The proposed route is vague on its location particularly along Davey Street.
No position of embarkation points or requirements of stops are noted.
No detail or mention is made as to the method of power supply to the tram. (overhead cable ,in-ground electric or automotive)
Similarly no detail is provided of turning radii of tram as several tight corners are envisaged.
The route appears to cross major roads in Morrison, Murray, Argyle Evans Streets and Franklin Wharf and will ultimately impact on future traffic patterns within the cove and precincts.
The proposed route appears to traverse for a total length of approx. 500 metres inside the Hobart Ports Corporation property from Watermens Dock to Hunter Esplanade.

Based on the above several areas of note are as follows.

Docks Area
The existing walls were constructed well over 100 years ago of unreinforced mortar and packed rockfill
No tiebacks or anchor walls were constructed
Reconstruction work in the 1960s along Constitution Dock was of lightweight precast cantilevered concrete units with transverse expansion joints. These concrete units were seated directly on top of the old walls on a bedding base .and a topping cast was placed over the backfill and units.
Excavation was limited to exposing a working area to place the units and bedding base.
Compaction by vibratory powered roller was restricted to approx. 4 metres behind the faceline.
Services are under the dock walls and in the fill
Concerns were raised from this office at the time of planting the trees and surrounds as this precluded access to any vessel moored on the Davey Street frontage in time of emergency.

The Sydney-Hobart honour brick paving has now been placed in the footpath
Contours are directed to discharge stormwater over the dock walls
Public seating has been installed on the margins.

Victoria Dock walls are of unreinforced lime mortar and packed rockfill construction ,similarly with no tiebacks or anchor walls
The Hobart rivulet overflow discharges via a large tunnel under Davey Street into the south-west corner of the dock. Service ducts containing power and water meters are also located in this area.
An entry and exit to Fishermans Market from Davey Street is also provided
The Davey Street frontage provides working access to the fishing vessels at the finger piers in the dock, and a defined clearway has been delineated by the fire services for access and emergency vehicles.

Concrete Roadways
The construction is about 50 years old ,heavily reinforced for high traffic loadings and up to 400 mm thick concrete.
Contours are formed away from crowns that have little relation to the present road alignments.

General
Any works along the edges of the docks should preserve the current accesses and clearances and note our concerns about the structural capacity of the walls themselves
Any proposed construction should be all in concrete to preserve the current look and not have asphalt margins.
Care would need to be undertaken if margins at the sides of the tracks are to be constructed as to still allow the port fork lift truck clearances.
Proposed construction would need to address existing contours.
Proposed construction route should respect and observe current traffic conditions and flow.within the working port.
Vehicular access would still be required.
Overhead wiring is not an option within the port area.
I hope that this information and preliminary assessment will assist with your deliberations.

Yours faithfully,

Bob Grundy

R.M.(Bob) Grundy
Engineering Associate Survey

Tasrail

Australian National

P.O. Box 107,
27 Hoblers Bridge Road,
Newstead, Launceston, Tas. 7250
Telephone: (03) 6337 2211
Facsimile: (03) 6337 2219

Our Reference:

96/039
TAS-1030
RHB:LMM

21 May, 1997

Mr Ian Johnstone
Johnstone, McGee & Sandy Pty Ltd
Consulting Engineers
117 Harrington Street
Hobart TAS 7000

RECEIVED 22 MAY 1997

Dear Mr Johnstone,

Hobart Tramway Project

Thank you for your fax of 14 May 1997.

As mentioned to you on the telephone today we do not wish to make any commitment on behalf of Tasrail re this project.

I therefore suggest you contact our new owners - whoever they may be, in due course.

However, as stated there are a number of issues/areas of concern which I feel obliged to acquaint you with:

1. We estimate necessary infrastructure upgrades for passenger traffic would cost in the order of $225,000.

2. We are concerned about public liability aspects of the proposal.

3. Any access fee chargeable, should we agree to the use of our track, would have to include an ongoing maintenance component.

4. the catenary system must be well outside our minimum structure limits.

5. A major safety/operational problem would occur with shunting in our Macquarie Point yards if passenger trains were to traverse this area.

Yours faithfully

Rene Blaszak
General Manager

ISO 9002 SGS

MAJOR STAKEHOLDERS INTERVIEW

Stakeholder: International Catamarans / Theme Park

Stakeholder Representative: Mr R Clifford

Date of Interview: 2 July 1997

QUESTIONS

1. **Support the project in principle** Yes

2. **Would consider financial support** No

3. **Would consider support in kind** Yes
   - **Access over land**
   - **Provision of land for tracks**
   - **Provision of land for sheds, depot etc.**
   - **Use of existing track** Provided not interfere with other use of track

4. **Support Other:**
   - Possible use of station proposed near Royal Engineers Building

5. **Problems**

6. **Any events, activities, functions which might impact on route options / selections.**
   - NA

7. **Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.**
   - NA

8. **Benefits to your organisation**
   - Mutual support of tourism complimentary to proposed operation of Steam Train and modern diesel rail car between the Theme Park Site and Royal Engineers Building.

9. **Benefits to the community & Business.**
   - Tourism generally

10. **Desirable control points ie tram stop or transport interchange points.**
    - Royal Engineers Building

Noted: No intent at this time for Theme Park Train to extend into dock area. Will terminate at a station to be built adjacent the Royal Engineers Building. Old style proposed. Possible display of steam engine opposite the Gas Works. Steam train or Diesel Rail Car could be running at 1/2 hour intervals on busy days.

MAJOR STAKEHOLDERS INTERVIEW

Stakeholder:	City Heart Association
Stakeholder Representative:	Barry Pickard
Date of Interview:	5 June 1997

QUESTIONS

1. **Support the project in principle** Yes

2. **Would consider financial support** No. Not appropriate

3. **Would consider support in kind**
   - **Access over land** NA
   - **Provision of land for tracks** NA
   - **Provision of land for sheds, depot etc.** NA
   - **Use of existing track** NA

4. **Support Other:**
   - Possibility of promotion / advertising in conjunction with other promotions. Support quality, and of benefits of city.
   - Branch into City - to Franklin Square should be considered.

5. **Problems**
   - Overhead cables not seen as desirable as on edge of dock not within on the city between buildings etc as say Melbourne.

6. **Any events, activities, functions which might impact on route options / selections.**
   - Nothing directly related to City Heart Only concern is if disrupts traffic.

7. **Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.**
   - NA

8. **Benefits to your organisation**
   - General, overall benefit to greater City.

9. **Benefits to the community & Business.**
   - General, big picture, promotion of greater City area.

10. **Desirable control points ie tram stop or transport interchange points.**
   - Hunger Street seen as desirable at some time
   - Cruise ships and warships
   - Franklin Square or other branch into or towards city centre.

HOBART CITY COUNCIL
TRAMWAY PROJECT
SULLIVANS COVE, HOBART

Johnstone McGee & Gandy Pty. Ltd
in association with
Connell Wagner Pty. Ltd

IT-Stkho

MAJOR STAKEHOLDERS INTERVIEW

RECEIVED 19 JUN 1997
ITS 6

Stakeholder : DEPARTMENT OF TRANSPORT

Stakeholder Representative : TRAFFIC MANAGEMENT BRANCH - CHIEF TRAFFIC ENGINEER

Date of Interview :

Questions :

1. Support the project in principle — Yes / No / Maybe

2. Would consider financial support — Yes / No / Maybe

3. Would consider support in kind — Yes / No / Maybe

- Access over land
- Provision of land for tracks
- Provision of land for sheds, depot etc
- Use of existing track

4. Support Other : TRAFFIC MANAGEMENT ADVICE

5. Problems : AERIAL CABLING, PEDESTRIAN ACCESS, STREET LIGHTING, ACCESS CROSSING TO MURES, EVANS STREET

6. Any events, activities, functions which might impact on route options / selections

LOSS OF PARKING, ON ROAD SECTORS REQUIRE CONSIDERATION, PEDESTRIANISATION OF ROUTE, ROAD CROSSINGS

7. Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.

N/A

8. Benefits to your organisation

ENHANCEMENT OF TRANSPORT SYSTEM, LINK TO METRO SERVICES

9. Benefits to the community

TOURISM, POSSIBLE COMMUTER OPTION

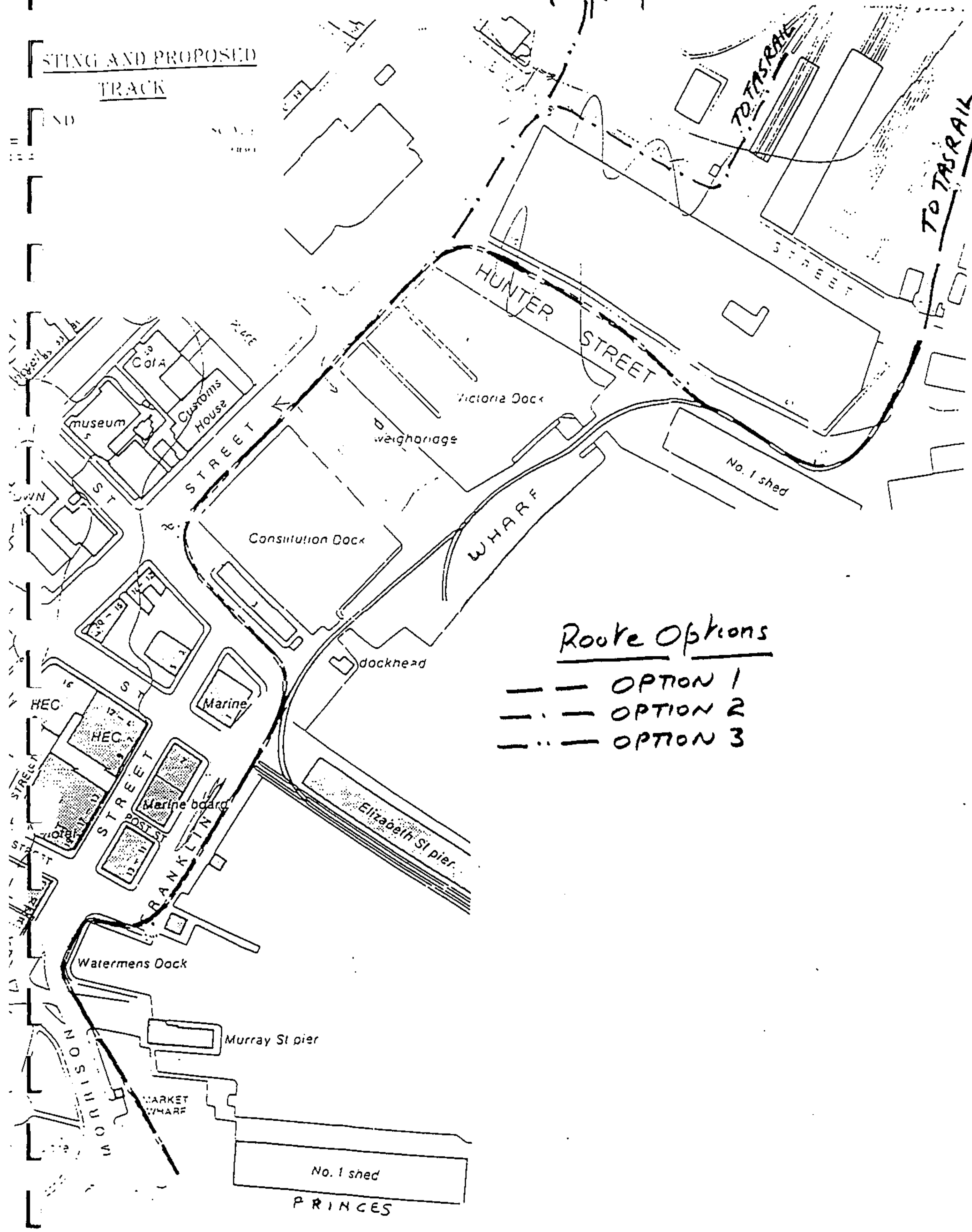
10. Desirable control points i.e. tram stop or transport interchange points

SALAMANCA PLACE, ELIZABETH STREET PIER, MURES, HUNTER STREET, GAS WORKS/WOOLSTORE, BEGINNING OF CYCLE TRACK, BOTANICAL GARDENS*, CORNELIAN BAY

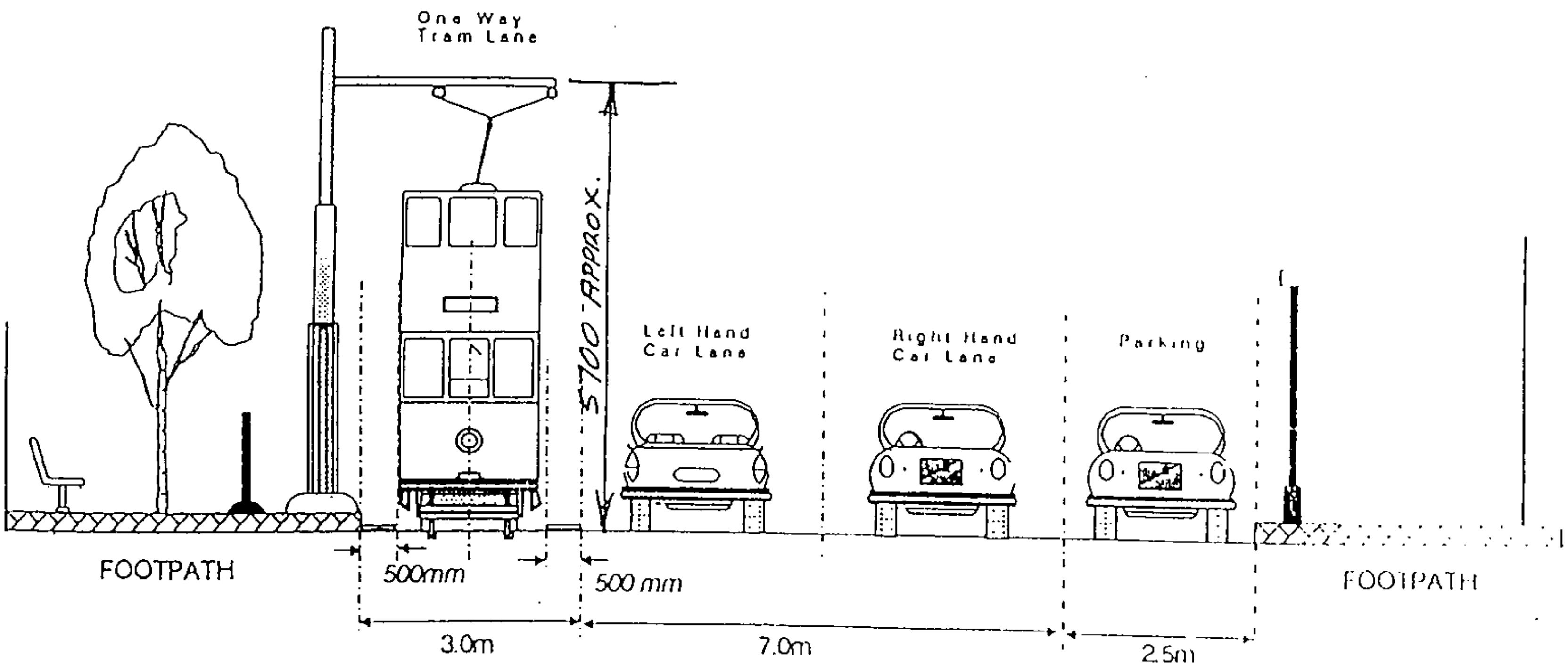
* CONNECT TO CRUISE OPERATION

18/P9

TO TASRAIL **SKETCH 1**



SKETCH 2



Melbourne Transport International	Drawing No MT-9011008
KERBSIDE TRACK 12.5 m Road Width	

MAJOR STAKEHOLDERS INTERVIEW

Stakeholder:	Tasmanian Transport Museum Society
Stakeholder Representative:	Graham Clements (President)
Date of Interview:	16 July 1997

QUESTIONS

1. **Support the project in principle** Yes

2. **Would consider financial support** No

3. **Would consider support in kind**
   - **Access over land** NA
   - **Provision of land for tracks** NA
   - **Provision of land for sheds, depot etc.** NA
   - **Use of existing track** NA

4. **Support Other:**
   - Advice from historical perspective including body, restoration, superstructure.

5. **Problems**
   - Footbridge at Regatta Ground too low?
   - Possible Tasman Bridge also
   - Terminal at Botanical Garden, road crossing, safety etc. Overpass, cut & cover etc possibilities.

6. **Any events, activities, functions which might impact on route options / selections.**
   - NA

7. **Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.**
   - NA

8. **Benefits to your organisation**
   - General increase in awareness of Transport Heritage and Tasmania particularly

9. **Benefits to the community & Business.**
   - Linking Botanical Gardens & Salamanca
   - Linking Royal Engineers Side of Sullivans Cove to Salamanca

10. **Desirable control points ie tram stop or transport interchange points.**
    Ferry, near city centre, Constitution Dock / Mures

    Double decker would be desireable. Maximum authenticity

MAJOR STAKEHOLDERS INTERVIEW

Stakeholder: Sullivans Cove Merchants Association

Stakeholder Representative: Jeffrey Thomas

Date of Interview: 11 July 1997

QUESTIONS

1. **Support the project in principle** Maybe

2. **Would consider financial support** No

3. **Would consider support in kind** No
   - **Access over land**
   - **Provision of land for tracks**
   - **Provision of land for sheds, depot etc.**
   - **Use of existing track**

4. **Support Other:**

5. **Problems**
   - Seasonal Concerns

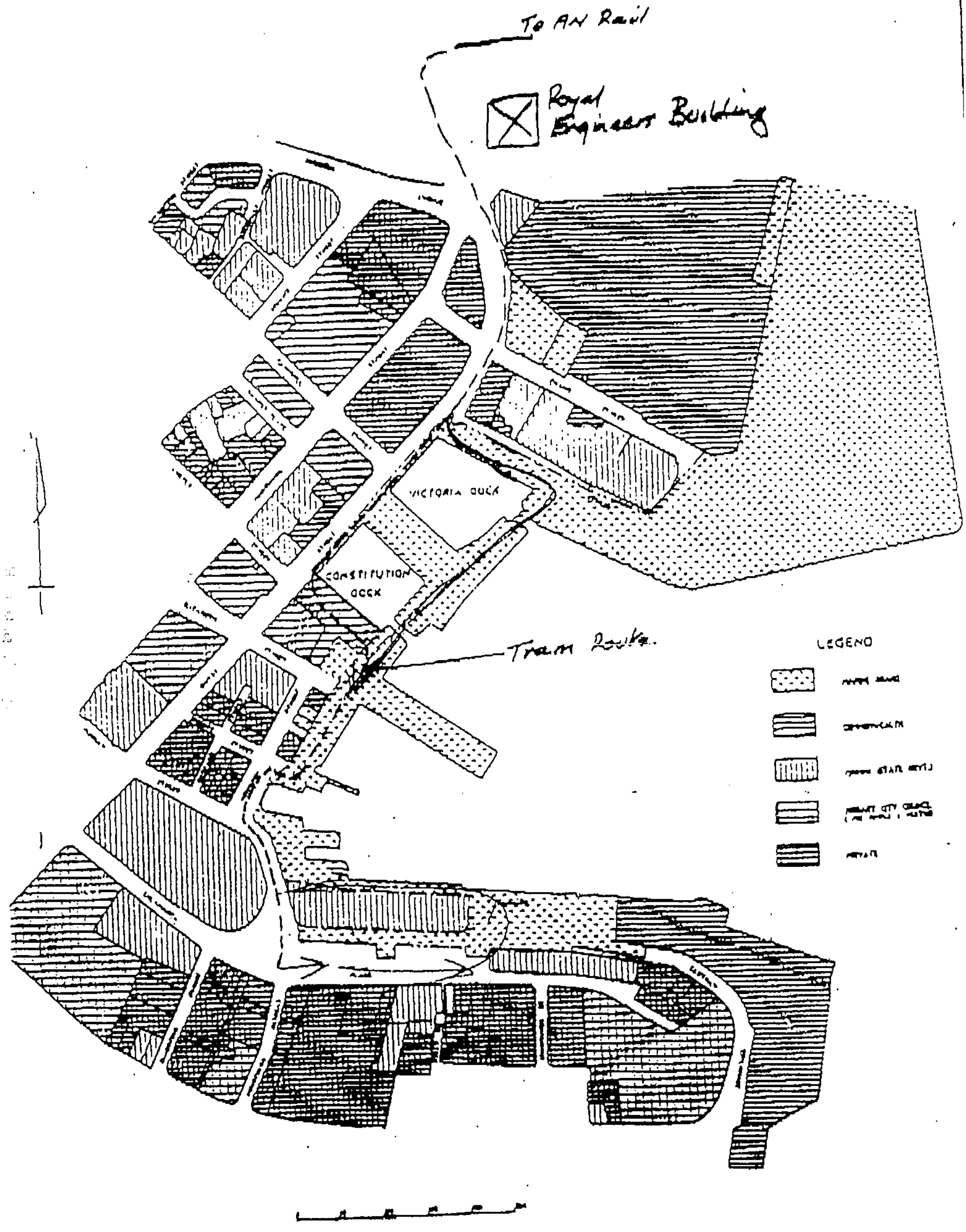
6. **Any events, activities, functions which might impact on route options / selections.**
   - No

7. **Knowledge of ground conditions, existing pavements, existing structures on or adjacent the current route options.**
   - No

8. **Benefits to your organisation**
   - Bring tourists into Sullivans Cove preferably via Victoria Dock, Constitution Dock area.

9. **Benefits to the community & Business.**
   - Yes

10. **Desirable control points ie tram stop or transport interchange points.**
   - Hunter Street, Victoria Dock, Constitution Dock, Salamanca Place.



CITY OF HOBART

LAND TENURE

SULLIVANS COVE - WAPPING